Effects of Constructivist Method of Teaching Basic Science and Mathematics on the Academic Performance of Junior Secondary Students' in Calabar Municipality, Cross River State, Nigeria.

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Abstract

This study investigated the effects of constructivist method of teaching basic science and mathematics on the academic performance of junior secondary school 3 students in Calabar Municipality, Cross River State, Nigeria. Two hypotheses were formulated to guide the study with some conceptual works reviewed. A total of one hundred and eighty-six (186) basic science and mathematics students, comprising four intact classes were selected from a population of 2684 JSS3 students in public secondary schools. Simple random sampling technique was used to select the schools. Two groups, namely: the experimental group and control group were used for the study. The study used a non-equivalent, pre-test, post-test, quasi-experimental design. Basic Science and Mathematics Performance Test (BSMPT) instrument, which consists of 15 test items each, was used to get data, with a reliability coefficient of 0.82 obtained using Kuder-Richardson-21 formula. Analysis of covariance (ANCOVA) was used for data analysis. The result showed that students taught using the constructivist method had a higher mean than those who were taught using the traditional lecture method. Based on the results obtained, recommendations were made, one of which was that workshops and seminars should be organised by the Ministry of Education in conjunction with professional bodies on how to use this innovative method in order to make learning realistic.

Keywords: Constructivist method, Basic Science and Mathematics.

Introduction

The contemporary goal of education is to provide an equal educational opportunity for learners no matter the level of aptitude, intelligence or previous achievement. The type of instructional strategy that can help us to achieve the aim of science and mathematics education is, therefore, a great concern to nations that desire to develop technologically. Educators, like Comerchero (2000) and Ajewole (2005), recognised the need to individualise instruction so as to cope with individual differences.

Teaching in basic science and mathematics is aimed at achieving some objectives which typically manifest into instructional products or students' academic achievement. Often, the nature and intensity of the outcomes, the behavioural changes in the learner are functions of the specific instructional approach. The emphasis on exact instructional strategy for optimum learning has received considerable notice among science educators in Nigeria (Adenuga, 2000; Aremu, 2005). Martins & Oyebanji (2006); Nwachukwu & Nwosu (2007) pointed out that the effectiveness of any instructional strategy,

to some extent, depends on the operator of the strategy. Also, other research findings, such as those of Medahunsi (2001) and Owolabi (2006), have identified instructional strategy as a major factor responsible for students' poor performance in science and mathematics. The use of inappropriate instructional strategies for the teaching of basic science and mathematics has been found to compound students' fright, making them to develop negative attitude towards studying science subjects in their next level of education. It has been observed that many of our science teachers are poorly trained in science and mathematics contents or methodology or both and this has adversely affected the performance of students in basic science and mathematics (Osisioma, 2005; Nwachukwu & Nwosu, 2007).

More recently, the rekindled concern for basic science students' learning outcomes has made the effects of instructional strategies on students' learning outcomes a point of convergence for educational researchers. In his study, Adenuga (2000) identified that, without instructional strategies, it will not be easy for students to understand the concepts the teacher is teaching. Although, many teaching strategies have been designed to aid learning. There is the need to still develop strategies that will enhance desirable learning outcomes among science and mathematics students. This research work is set out to determine the effects of constructivist method of teaching basic science and mathematics on secondary school students' performance.

Constructivist method, in this study, implies that learners must actively construct and develop their own concept of the subject matter. The fundamental reason for this method is that it helps learners to gain understanding thereby creating links with previous knowledge. Science is an intellectual activity carried out by humans and is designed to discover information about the natural world in which humans live. It is also to discover the ways in which this information can be organised into meaningful patterns. An ultimate purpose of basic science is to discern the order that exists between and among

subjects like physics, chemistry, biology (Gottlieb, 2011). Despite the importance of basic science and mathematics, most Nigerian students have shown persistent low performance in the subjects at internal and external examinations. A cursory look at past performance of students in JSSCE basic science from 2012-2017 shows the following: 50.77%, 48.21%, 46.70%, 44.54%, 43.13%, and 41.96% respectively (FME, 2018). From the above result, it is clear that there is a decline in students' academic performance in basic science and mathematics.

Literature Review

Some research findings have shown that the use of inappropriate methods in teaching is perhaps the reason for poor academic achievement. Ali (2000) and Musa (2000) revealed that some teaching methods are more effective for learning than others. Evidence in Ekon, Ekwueme & Meremikwu (2014) confirmed that students taught with five phases of constructivist instructional model performed far better than those taught basic science and mathematics using the conventional method. Duyilemi and Bolajoko (2014) conducted an investigation on the effects of constructivists learning strategies on senior secondary school students' achievement and retention in biology. The study investigated the effects of constructivist learning strategies on students' achievement and retention in biology in selected senior secondary schools in Owo Local government Area of Ondo State. The study adopted a pre-test, post-test, control, retention, quasi-experimental design. A total of one hundred and sixty students from two co-educational schools participated in the study. Eighty (80) students served as the experimental group, while 80 served as the control group. Three research instruments were used for the study. These were biology achievement test, teacher's instructional guide on: constructivist strategies and instructional guide on conventional method. Two research questions and two null hypotheses were tested at 0.05 levels of significance. Analyses of data were carried out using Analysis of Covariance (ANCOVA) and multiple classification

Analysis (MCA). The result obtained showed that there were significant main effects of treatment on students' achievement and retention in experimental group. Male students had higher achievement scores than their female counterparts in the experimental group. The implication is that the constructivist learning strategies should be emphasised more than the conventional method in order to enhance the performance of students in biology. However, the present work is aimed at investigating the effect of Constructivist Method on junior secondary students' academic performance in basic science and mathematics in Calabar Municipality.

Tagbo (2014) investigated the effect of 5Es constructivist instructional model on students' achievement and attitude to chemistry. The study was carried out in Nsukka Local Government Area of Enugu State. Purposive sampling technique was used in selecting four co-educational secondary schools out of the 30 secondary schools in Nsukka L.G.A. Two instruments were used for data collection in this study, namely: Chemistry Achievement Test (CAT) and Student's Attitude Scale (SAS). Six research questions and six hypotheses guided this study. The data collected for the research questions were analysed using mean and standard deviation and the hypotheses were tested using Analysis of Covariance (ANCOVA). The result, among others, revealed that 5Es constructivist instructional approach was superior to conventional instructional method (lecture) in facilitating students' achievement and attitude to chemistry than the conventional lecture method. There was no significant difference in the mean scores of male and female students in chemistry after the treatment, although male students performed slightly better than their female counterparts.

Agogo and Naakaa (2014) investigated how the 5Es constructivist instructional strategy would improve students' interest in senior secondary school genetics in Gwer Local Government Area of Benue State, Nigeria. The design of the study was quasi experimental, specifically. The pretest post-test non-equivalent control group design was used. The study used a sample of 147 out of a population of 2,183 SSII biology students from four schools. A validated 30 item genetics interest inventory (GII) was the instrument for data collection. A reliability co-efficient of 0.85 was established for the GII using Cronbach Alpha method. Out of the four schools, two were assigned to the experimental group while the other two were assigned to the control group. The experimental group was taught genetics using the 5Es (engagement, exploration, explanation, elaboration and evaluation) constructivist instructional strategy while the control group was taught using the conventional (lecture) method. Mean and standard deviation were used to answer the two research questions and analysis of Covariance (ANCOVA) was used to test two hypotheses at $P<0.05$ level of significance. The result revealed that the 5Es constructivist instructional strategy was more effective in facilitating students' retention of genetics concepts and their interest in genetics in both urban and rural schools. The study recommended, among others, that the 5Es constructivist instructional strategy be adopted in our school system for teaching biology, especially genetics and other science contents.

Aligba (2011) also found out that the use of integrated constructivist strategy has significant positive effect on the mean achievement scores of senior secondary students' in mensuration and probability. One moderator variable considered relevant to this study is gender. For many decades, researches have been carried out on gender as it affects students' academic performance in basic science and mathematics. This is in view of the contradictory results obtained, some showed that males performed better than their female counterparts in science and mathematics (Olaniyi, 2009; Aligba, 2011 and Babayemi, 2014), while the finding of Soltani and Nasri (2010) showed that females do better than males in science subjects. Afuwape and Oludipe (2008) and Yuwen (2008) reported a decline in gender differences in science and

mathematics. Several studies have revealed that there exists a relationship among teachers' methodology, kitchen resources, students' variables, gender and students' academic achievements (Ojo, 2001; Akinola, 2006; Nja & Neji, 2013; Adie, Anditung & Inah, 2019).

From the foregoing, it is clear that scholars have worked on diverse instructional strategies, gender and their effects on students' academic achievement, though not using two subjects at a time, yet mixed results. It is, therefore, important to investigate the effects of constructivist method on students' academic performance on these compulsory subjects in junior secondary schools in Calabar Municipality, Cross River State.

Theoretical framework

This work is anchored on the theory of cognitive constructivism, pioneered by Jean Piaget (1936), which is of the view that learning occurs when learners are actively involved in the process of learning and knowledge construction from their previous knowledge rather than as passive recipients of information. The theory of cognitive development proposes that learners do not gain knowledge from outside, rather they interpret and process new information through the creation of knowledge. Since constructivism implies making meaning based on experiences, it follows that the achievement level of a learner in the classroom is determined by the learner's ability to construct meaning out of the experience s/he has acquired. The constructivist looks at how learners learn. They believe that the learners are active participants in the teaching-learning situation and they construct their own knowledge and understanding as they develop mentally.

The theory is based on the following assumptions:

a) Individuals actively seek out information from their environment to help them explore.

b) Individuals build and construct new knowledge based on their experiences and interactions with their immediate world.

c) Individuals learn through the process of assimilation (dealing with a new event in a way that is consistent with an existing scheme) and accommodation (dealing with new information by modifying existing skills.

Implications of constructivist theory to the study:

I. It helps the teacher to understand the mental models that learners use to perceive their environment.

II. It helps to plan a lesson that can encourage them to construct their meaning not just to memorise the right answer and also making them active participants in the teaching–learning process.

Statement of the problem

In recent times, it has been observed that students' academic performance in basic science and mathematics at the junior secondary school level has continued to decrease in spite of government's huge effort and budget to revamp the education sector at all levels. One notable factor that has been pointed out as responsible for this decline is the teaching method. It is on this note that the researcher is investigating the effects of constructivist method of teaching basic science and mathematics on the academic performance of junior secondary students in Calabar Municipality, Cross River State.

Purpose of study

The purpose of this study was to determine the effects of constructivist method of teaching basic science and mathematics on the academic performance of JSS3 students. Specifically, the study was to determine:

1. How the constructivist method affects junior secondary students' basic science and mathematics academic performance.
2. Effect of gender on junior secondary students' academic performance in basic science and mathematics taught using constructivist method.

Statement of hypotheses

1. There is no significant difference between the mean academic performance of students taught basic science and mathematics with constructivist method and those taught with lecture method.
2. Gender does not significantly affect the academic performance of students taught with constructivists and lecture method.

Research methodology

Results

The research adopted a quasi-experimental design. It was a pre-test, post-test, control group, quasi-experimental design. Reliability coefficient of 0.82 was achieved using Kuder Richardsons-21 formula for basic science and mathematics performance test instrument used (BSMPT). A sample size of 186 students comprising four intact classes was selected from a population of 2684 junior secondary school students in public schools in Calabar Municipality of Cross River State. Analysis of covariance (ANCOVA) was used to analyse data.

Table 1

Mean, standard deviation and summary of 2 x 2 analysis of covariance of effect of treatment and gender on JSS3 basic science and mathematics students' academic achievement.

Treatment	Gender	Mean	Std. Deviation	N
Experimental	Male	38.00	8.88	50
	Female	37.00	9.62	46
	Total	37.60	9.19	96
Control	Male	16.12	5.26	40
	Female	16.12	7.07	50
	Total	16.73	6.40	90
Total	Male	33.82	16.72	90
	Female	30.51	17.66	96
	Total	32.25	17.35	186

Source of Variation	Sum of Squares	Df	Mean Squares	F	Signal Level	Partial ETA
-Corrected Model	46324.74	4	12464.457	233.333	.000*	.752
-Intercept	27223.811	1	27223.811	550.237	.000*	.701
-Pretest	2344.321c	1	2344.321	24.682	.000*	.151
-Treatment	2344.321	1	2344.321	1019.410	.000*	.813
-Gender	102.726	1	102.726	2.142	.124	.021
-Treatment X Gender	12.04	1	12.049	.242	.508	.166
		9				
Error	1228.018	235	531.153			
Total	321455.000	240				
Corrected	71951.000	239			S	

Data on table 1 shows that the experimental group has a higher mean than the control group 37.60 and 16.73 respectively. Males in the experimental group have a slightly higher mean (38.00) than females (37.89). The table also indicate that treatment was significant (F = 1019.410, P< .05); interaction of treatment and gender was not significant (F = 0.242, P > .05); thus, the first null hypothesis was rejected.

The table further indicates that treatment contributed 81.3% of the variance; gender was 21.1% while interaction effect between treatment and gender was 16.6%. This result implies that students' gender did not significantly influence their performance in basic science and mathematics when taught using constructivist method and lecture method. The first null hypothesis was rejected, meaning that there was a significant difference in the academic performance of students in basic science and mathematics when taught using constructivist method and lecture method. The second null hypothesis was retained with respect to interaction of gender and treatment.

Discussions

The finding of this study is in agreement with other studies of Aligba (2011); Ekon, Ekwueme & Meremikwu (2014) in basic science and mathematics which suggested that the integrated and five phase constructivist method has a much greater effect on students' academic achievement than the traditional method. The result of this study, which is corroborated by the findings of Duyilemi and Bolajoko (2014); Agogo & Naakaa (2014) and Tagbo (2014), as investigated upon in biology and chemistry respectively, reveals that there is a significant main effect of treatment on

students' achievement, retention, interest, and attitude. The implication is that the constructivists' learning strategies should be emphasised more than the conventional (lecture) method in order to enhance performance of students in biology and chemistry respectively.

According to the study, gender was not significant. This implies that both male and female students achieved equally under the same condition during the teaching and learning process. This is so because achievement has to do with mental and intellectual ability and not gender. This agrees with the findings of Afuwape and Oludipe (2008); Yuwen (2008) and Tagbo (2014) who found that there was no significant statistical difference between the achievement of male and female students in the subjects. However, this is contrary to the view of Duyilemi and Bolajoko (2014) who found that male students achieve higher than their female counterparts in the experimental group.

Conclusion

The study revealed that the use of constructivist teaching method is more effective than the use of lecture method in teaching basic science and mathematics. Moreover, constructivist method is friendly irrespective of gender; hence, student-centred approaches should be encouraged.

Recommendations

1. Basic Science and Mathematics teachers should be encouraged to use this method since it is not gender biased.
2. Workshops or seminars should be organised by Ministry of Education in collaboration with professional bodies on how to use this innovative strategy.

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Test questions on Basic Science and Mathematics

1. Which of these is a characteristic of living things? (a) irritability (b) stone (c) all of the above (d) none of the above
2. Energy is the ability to do _____ (a) power (b) force (c) energy (d) work
3. Neutralization is a process by which acid and base react to form _____ (a) water (b) particles (c) salt (d) salt and water

4. A PH value of 7.0 represents _____(a) neutral (b) acidic (c) alkaline (d) regular
5. What is a skeleton? (a) A bony framework of the body (b) skin that covers the bone (c) a woody framework (d) none of the above
6. The change of a substance from a liquid state to a gaseous state is known as _____ (a) condensation (b) melting (c) evaporation (d) freezing
7. At what degree does water change to steam? (a) 10^0 (b) 50^0 (c) 90^0 (d) 100^0
8. The functional unit of life is called _____ (a) blood (b) cell (c) organ (d) system
9. H_2o is made up of _____and_____ (a) hydrogen and oxygen (b) water and salt (c) chlorine and iodine (d) nitrogen and oxygen
10. The process by which green plants manufacture their own food is known as _____ (a) Photosynthesis (b) sunlight (c) fertilization (d) oxygenation
11. Which of these is an element? (a) water (b) timber (c) sodium (d) stone
12. _____are substances that help to speed up chemical reaction (a) chlorophyll (b) catalyst (c) crystallization (d) Sterilization
13. A number is selected at random from 1 to 20. What is the probability that the number is an odd number? (a) $\frac{5}{21}$ (b) $\frac{1}{3}$ (c) $\frac{2}{7}$ (d) $\frac{1}{2}$
14. Express 11011_{two} in denary (a) 17_{ten} (b) 28_{ten} (c) 45_{ten} (d) 27_{ten}
15. Find the median of the following numbers: 2.64, 2.50, 2.72, 2.91, and 2.35 (a) 2.91 (b) 2.72 (c) 2.64 (d) 2.50
16. A regular polygon has 9 sides. What is the size of one of its exterior angle? (a) 20^0 (b) 40^0 (c) 90^0 (d) 140^0
17. When the sum of 12 and a certain number is divided by 3, the result is 4. Find the number (a) 24   (b) 15   (c) 5   (d) 0
18. Calculate the sum of 3 dozens, 8 scores and 12 gross (a) 288 (b) 1942 (c) 1924 (d) 182
19. Evaluate correct to 4 decimal places 827.51 0 × 0.015 (a) 12.4127 (b) 12.4120 (c) 114.1265 (d) 12.4321
20. The average of three numbers is 3. If the mode is 4, find the largest number. (a) 1 (b) 3 (c) 4 (d)5
21. Four-fifth of a 10m long electric pole is above the ground. What is the length above the ground? (a) 8m (b) 10m (c) 12m (d) 20m
22. 6 men can dig a pit in 4 days. How long will it take 4 men working at the same rate to dig the same pit? (a) 14 days (b) 8 days (c) 6 days (d) 2days
23. In 1984, Francis was 24 years and his father was 45 years old. In what year was Francis exactly half his father's age? (a) 1982 (b) 1981 (c) 1979 (d) 1978
24. Calculate the sum of 3 dozens, 8 scores and 12 gross (a) 288 (b) 1942 (c) 1924 (d) 182
25. In a class of 50 students, 30% of the students watch cartoon. What is the number of those who do not watch cartoon? (a) 13 (b) 35 (c) 15 (d) 30

Answers
1.A   2.D   3.D   4.A 5.A   6. C 7.D 8.B 9.A 10.A 11.C 12.B 13.D 14.D   15.C 16.B 17.D 18.C 19.A 20.C   21.A 22.C   23.B 24.C 25.B