



Effect of Concentric Teaching Approach on Academic Performance of Senior Secondary School Students in Mathematics in Adamawa State, Nigeria

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Abstract

The study investigated the effect of concentric teaching approach on academic performance of secondary school students in the Jada Local Government Area of Adamawa State. Two research questions and two null hypotheses guided the study and the hypotheses were tested at 0.05 alpha level. This study adopted the pretest post-test non-equivalent control group quasi-experimental design. The population of the study consisted of 1,200 secondary school year two (SS11) students offering mathematics in the Jada Local Government Area of Adamawa State. The sample size for the study was 220 SS11 mathematics students obtained using both purposive and random sampling techniques. The instrument used for data collection was the Geometry Achievement Test (GAT). Face and content validity of (GAT) were carried out by two senior lecturers in the departments of mathematics and physical sciences education of the Modibbo Adama University Yola. GAT reliability was established using Kuder Richardson 21 (K-R 21) to be 0.74. Data relating to the research questions was answered using mean and standard deviation and the hypotheses were tested using analysis of covariance (ANCOVA). The findings of the study revealed that there was a significant difference between the mean performance scores of students taught mathematics using concentric teaching approach and conventional method in favour of a concentric teaching approach. However, no significant difference was found between the mean performance scores of boys and girls when taught using the concentric teaching approach. Based on the findings, the researcher recommended that mathematics teacher adopt a gender-friendly concentric teaching approach that encourages cognitive engagement and integration of prior knowledge for effective learning of mathematical concepts.

Keywords: Concentric teaching approach, academic performance, geometry

Introduction

The need for Nigeria to nurture its youth with relevant knowledge in the field of science and technology to facilitate the country's aspirations for self-reliance and make meaningful contributions in the pursuit of national development cannot be overemphasized. Unfortunately, the country's aspirations for self-reliance have not yet been fully achieved. One of the areas of science and technology that poses great challenges to young people from primary school to higher education is mathematics this is because a lot of young people could not gain admission to institutions of higher learning after the completion of their secondary school education.

According to Iyoke(2015), mathematics is a science visualized in symbols, logical statement, shapes, numerical quantities and arrangement. Mathematics is used worldwide as an important tool in

various fields, including natural sciences, medicine, engineering, and social sciences. Mathematics plays an important role in the advancement of science and technology. It is important for understanding other disciplines such as economics, physics, chemistry, etc. Scientists use mathematics to design experiments and analyze data. Therefore, mathematics is an essential tool for human survival regardless of culture, gender, race, discipline, or religion.

Mathematics is an organized series of relations among mathematical concepts and teaching mathematics therefore requires the learning process of new mathematical knowledge on the basis of pre-requisite and pre-experience of learners under the guidance of teachers. This is because for any country like Nigeria that is engaged in nation building to achieve greater success, it must first produce people



with logical minds. One of the goals of teaching secondary school Mathematics is to develop in students the ability to recognize problems and to solve them with related mathematical knowledge (NPE, 2013).

Students' performance in mathematics as a school subject is appalling, as evidenced by annual failures in public examinations such as the Senior

Secondary School Certificate Examinations conducted by the West African Examinations Council (WAEC) and the National Examinations Council NECO. The WAEC Chief Examiners' Report (2015) and WAEC Chief Examiners' Report (2017) show that some students do not perform well in mathematics, particularly geometry.

Table 1: Students' Performance in SSCE (WAEC) in mathematics from 2011 - 2020 in Adamawa State

Year	Male Enrolment	Female Enrolment	Total	No of Male Pass	No of female Pass	Total	%Pass
2011	15492	11327	26819	925	805	1730	6.5
2012	15982	11905	27887	1029	941	1970	7.1
2013	16425	12037	28462	1327	1105	2522	8.9
2014	17700	12535	30235	1510	1136	2646	0.1
2015	18204	12978	31182	3533	2254	5787	18.6
2016	18903	13304	32007	8401	5816	14217	44.4
2017	19209	13948	33157	7592	6406	13998	42.2
2018	19942	14271	34213	6456	5395	11851	34.6
2019	17354	12070	29424	3987	3334	7321	24.9
2020	15256	12390	27646	5216	4618	9834	35.6

According to Usman, Agah and Okeke (2017), geometry is a field of mathematics that deals with the properties, relationships, and measurements of points, lines, curves, and spaces. This study draws from failure of students in geometry to investigate the effects of integration of the concentric teaching approach on students' learning of geometry.

Researchers such as Iji, Abakpa and Takor (2015) have identified causes of students' failure in Mathematics to include but not limited to: lack of frequent practice, inadequate grasp of its technical language, poor mathematical background of the students, influence of parents on child's career choice, incompetent handling of difficult Mathematics topics by teachers, poor pedagogical approach or strategies, non-involvement of learners in practical classroom activities and failure on the part of the teachers to relate Mathematics to real life activities. The problem of underachievement in mathematics is of great concern to the government, parents, mathematics teachers and researchers in mathematics and several attempts have been made to tackle the problem. From the results of previous researchers such as Salman, Ayinla, Adeniyi, Ogundele, & Ameen, (2012), it was deduced that the mode of instruction, especially at both primary and

secondary levels of education remains overwhelmingly teacher-centered, with greater emphasis on the use of the conventional mode of instruction and the use of textbooks rather than engaging students in critical thinking across subject areas and in applying the knowledge acquired to solving real life problems. The role of teachers at all levels of education is emphasized in the National Policy on Education that no nation or educational system can rise above the quality of its teachers. Teachers play an important role to bring about transformation in educational institution. The trained and competent teachers at all levels of school education enrich the institutional capacity. The quality and level of learner achievements are determined mostly by teacher competence, sensitivity, and teacher motivation.

This declaration underscores the need for teachers' effectiveness in the teaching and learning process. It is the teacher's competence, ability, resourcefulness and ingenuity through effective utilization of appropriate language, methodology and available instructional materials that could bring out the best from the learners in terms of academic performance. In Nigeria, the need for effective teaching



methods is paramount to address the challenges students face in understanding mathematical concepts.

In the quest for finding suitable innovative approaches to engage students and facilitate effective learning and address students' poor performance in mathematics especially in geometry, concentric teaching approach was opted for. The concentric approach emerges as a promising strategy, emphasizing a systematic and layered method which fosters comprehensive mathematical understanding. Concentric approach refers to the organization of mathematical concepts and skills into interconnected circles or concentric circles, reflecting their hierarchical and interconnected nature. The approach is based on the principle that learners learn things as a whole in their point of contact and gradual increase in difficulties. It is also based on the pedagogical principle of moving from known to unknown, familiar to unfamiliar, simple to complex, near to distant, concrete to abstract, etc.

With the use of this approach, teaching and learning is made relatively easy because the interest and curiosity of learners is aroused and retained as their active participation is assured because they learn from known to unknown. Furthermore, concentric teaching approach facilitates transfer of learning and promotes consolidation of knowledge of learning. It is based on Tyler's (1949) principle of sequence and continuity, which implies that sequence is moving from topics that are familiar and known to those unfamiliar and unknown, whereas, continuity has to do with broadening and deepening of major concepts, themes or topics of the curriculum. It also helps them to build connections between different topics, which can lead to a deeper understanding and more efficient learning and improved academic performance.

Also, another factor that influences students' academic performance in mathematics is students' gender. The term gender has attracted the attention of many researchers especially in the field of education since the process of teaching and learning involved the participation of both male and female students. Gender refers to social differentiation or cultural distinction between male and female and the attribution of certain roles based on differentiation (Abe, Egbon, & Aduloju, 2013). Result from research findings of Ezeudu and Obi (2013) revealed that male students perform better than females students in science subjects. However, the study of Ginga and Kauru (2019) revealed significant difference in achievement in favour of the females when they were taught mathematics with explicit teacher instruction

method in Daura, Katsina State. Furthermore, Ajaegba and Ekwueme (2019) found no significant difference in the mean performance scores of boys and girls in mathematics (geometry). What is not clear is whether academic achievement in science and mathematics varies depending on the teaching method. It is unknown if the use of concentric teaching approach can improve students' performance in mathematics. Therefore, the purpose of this study was to investigate the effect of concentric teaching approach on the academic performance students in mathematics in senior secondary schools in the Jada Local Government Area of Adamawa State.

Theoretical Bases for the Study

According to Pedro (2013), the theory of identical elements which was developed by the duo of Thorndike and Woodworth (American Psychologists) (1901) indicates that it is possible for an individual to transfer the prior skills and knowledge to recent ones because both experiences are identical (share things in common). This theory suggests that a successful or effective learning will happen if there are connections or interrelatedness between the old and the new experiences. The theory of identical elements is relevant to concentric teaching approach because if a student can identify the identical element between different learning tasks, they will be able to transfer their knowledge and skills more effectively.

Statement of the Problem

This article addressed the problem of secondary school students in the Jada Local Government Area performing poorly in Mathematics, especially Geometry, partly due to the ineffectiveness of mathematics teachers. Although there are many reasons for this, one of the most important is the use of rote learning and practices that do not allow students to understand mathematical concepts in depth. Additionally, mathematics teachers often do not have the necessary training and support to implement effective teaching methods. This leads to a vicious cycle of low academic performance and poor mathematics skills, which often has a negative impact on future career of students, especially those seeking admission to tertiary institutions. This problem is a big issue in Adamawa state as seen in Table 1 above and therefore calls for an urgent attention by government and other education stake holders.

In spite of studies in instructional methodology to improve students' achievement over the years, poor

achievement in mathematics in the state still persisted. This implies that, research on a variety of teaching strategies that can enhance students' achievement in mathematics must continue, hence concentric teaching approach was tested to find out whether the method could improve on students' academic performance in mathematics in the study area.

Purpose of the Study

The purpose of this study was to find out the effect of concentric teaching approach on academic performance of senior secondary school students in mathematics in Adamawa State, Nigeria. Specifically, the objectives of the study are to determine:

1. The effect of concentric teaching approach and conventional method on academic performance of senior secondary school II students in mathematics in Jada Local Government Area of Adamawa State.
2. The effect of gender on academic performance of senior secondary school II students taught mathematics using concentric teaching approach in Jada Local Government Area of Adamawa State.

Research Questions

The following research questions guided the researcher in this study;

1. What are the mean performance scores of SS II students taught geometry with concentric teaching approach and those taught using conventional method?
2. What are the mean performance scores of SS II male and female students taught geometry using concentric teaching approach and those taught using conventional method?

Hypotheses

The following hypotheses were formulated and tested at 0.05 level of significance.

H₀₁. There is no significant difference in the mean performance scores of SS II students taught geometry using concentric teaching approach and those taught using conventional method

H₀₂ There is no significant difference in the the mean performance scores of male and female SS II students taught geometry using concentric teaching approach and those taught using conventional method .

Methodology

The research design employed in this study was pretest, posttest non –equivalent control group quasi-experimental design because the experimental and control groups were selected without randomization. The research subjects were not randomized because of the problem of re-arrangement or regrouping of intact classes. This study was carried out in the Jada Local Government Area of Adamawa State. A total of 220 senior secondary (SS) 2 students were drawn from 2 public schools in the Jada Local Government Area of Adamawa State. This comprises of 150 male and 70 female students. The number of students taught geometry using concentric teaching approach was made of 118 students that consist of 80 male and 38 female students' and 102 students were taught using conventional method. The sampling was concluded by purposively sampling 4 intact classes from 2 schools that have two arms of SS2 Classes and their mathematics teachers were graduates whose major area of specialization is mathematics. In each school used for the study SS II^A and SSII^B were randomly assigned as experimental and control groups hence the whole class were involved in the treatment in order not to disturb the school programme.

Accordingly, the respective mathematics teachers in each of the schools who were previously trained and ascertained to meet the selection criteria were used for the study. Training was conducted for the qualified mathematics teachers with or B.(Ed) or B.Sc (Ed) Mathematics who have had 3-years and above of teaching experience for the period of one week on the use of concentric teaching approach for geometry in senior secondary schools with the lesson plans for the treatment groups. The training was carried out through micro-teaching whereby the teachers were allowed to teach with the instrument under the watch of the researcher. This was to ensure homogeneity of instructional situation on the groups as much as possible.

The instrument, Geometry Achievement Test (GAT) was self-structured based on the lesson content and from WASSCE past questions; to check the academic performance of students in geometry. The (GAT) initially consisted of fifty multiple choice questions with four options A-D for each item. It was however reduced to 40 items after validation. (GAT) was administered as pretest and posttest to both the experimental and control group, to check if there is difference in the academic performance of the students in mathematics. The performance test has two sections



A and B. Section A is meant to gather bio data while section B contained a 40 multiple choice questions.

Face and content validity of the instrument (GAT) were carried out by three senior lecturers in the departments of mathematics and Physical Sciences Education, Modibbo Adama University Yola . The two sets of lesson plans prepared for both experimental and control groups were attached to the instrument for validation. The researcher sought the advice of the lecturers who validated the instrument, especially on the suitability, content and item construction, language used and correct options. Their suggestions, corrections and recommendations were effected to make the

instrument fit for the study. The reliability of (GAT) was determined by administering the test to 40 SS2 senior secondary school students in Numan Local Government Area of Adamawa State , K-R 21 was used to check for reliability, because it tends to be a more conservative estimate of reliability than KR-20 . The reliability index was found to be 0.74 which is an indication that the instrument is reliable.

The two groups (experimental and the control groups) were subjected to Geometry Achievement Test (GAT) as pre-test in which the scores were collated.

Results

Table 1: Mean Achievement Scores of Students taught Mathematics using Concentric Teaching Approach and Conventional Method

Source of Variation	N	Pretest Mean	SD	Posttest Mean	SD	Mean Gained
Experimental	118	31.70	5.44	60.47	6.89	28.77
Control	102	27.31	4.61	46.90	4.67	19.59
Difference in Mean		4.39		13.57		9.18

Table1 shows that the students taught mathematics using Concentric Teaching Approach has pretest mean achievement score of 31.70 and posttest mean achievement score of 60.47 with gained mean performance score of 28.77, while those in the control group taught with conventional method had pretest mean achievement score of 27.31 and posttest mean achievement score of 46.90 with gained mean 19.59 The difference between the gain

in mean achievement scores of the group taught using Concentric Teaching Approach and the group taught using Conventional Method is 9.18 in favour of Concentric Teaching Approach . From the table it can also be deduced that the standard deviation in experimental group is larger than the control group, suggesting that the data points in experimental group have greater variability compared to control group.

Table 2: Mean Achievement Scores of Male and Female Students taught Mathematics using Concentric Teaching Approach

Gender	N	Pretest Mean	SD	Posttest Mean	SD	Mean Gained
Male	80	31.33	4.68	60.74	6.12	29.41
Female	38	32.50	6.76	59.92	8.36	27.42
Difference in Mean		-1.17		0.82		1.99

Table 2 shows that the male students taught mathematics using Concentric Teaching Approach has pretest mean achievement score of 31.33 and posttest mean achievement score of 60.74 with gained mean

achievement score of 29.41, while those in the females had pretest mean achievement score of 32.30 and posttest mean achievement score of 59.92 with gained mean 27.42. The difference between the gain in mean



achievement scores of the male and female students taught mathematics using Concentric Teaching Approach is 1.99 in favour of females. Additionally the

difference in the standard deviation between male and female student is trivial as both genders exhibit similar variations in mathematical performance.

Table 3: ANCOVA on Significance of Difference between the Mean Achievement Scores of Students taught Geometry using Concentric Teaching Approach and Conventional Method

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	11457.969 ^a	2	5728.985	194.651	0.000	0.642
Intercept	9533.278	1	9533.278	323.908	0.000	0.599
Pretest	1379.685	1	1379.685	46.877	0.000	0.178
Methods	5978.751	1	5978.751	203.137	0.000	0.484
Error	6386.758	217	29.432			
Total	663692.000	220				
Corrected Total	17844.727	219				

a. R Squared = .642 (Adjusted R Squared = .639)

Table 3 shows $F(1, 219) = 203.137, P(0.000) < 0.05$. Therefore, the null hypothesis was rejected. Thus, there is a significant difference between the mean pretest and posttest achievement scores of students taught mathematics using concentric teaching approach

and those taught using conventional method in favour of concentric teaching approach. Partial Eta Squared of 0.484 is an indication that 48.4% of academic performance of students is accounted for by the method of teaching.

Table 4: ANCOVA on Significance of Difference between Mean Achievement Scores of Male and Female Students taught Mathematics using Concentric Teaching Approach

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1856.676 ^a	2	928.338	28.832	.000	.334
Intercept	4440.533	1	4440.533	137.914	.000	.545
Pretest	1839.503	1	1839.503	57.131	.000	.332
Gender	71.777	1	71.777	2.229	.138	.019
Error	3702.747	115	32.198			
Total	437106.000	118				
Corrected Total	5559.424	117				

a. R Squared = .334 (Adjusted R Squared = .322)

Table 4 shows $F(1, 117) = 2.229, P(0.138) > 0.05$. Therefore, the null hypothesis was not rejected. Thus There is no significant difference in the the mean performance scores of male and female SS II students taught geometry using concentric teaching approach

them active participants and alert as well as motivates or enhances their interest through building on their previous knowledge of the topic to be taught . Thus it was possible for students to improve in their achievement since Concentric teaching approach acted like a reinforcer and source of stimulation.

Discussion

Performance of students taught geometry using Concentric teaching approach is significantly higher than those students taught same with conventional strategy. This shows that the use of Concentric teaching approach in teaching geometry can improve students' achievement in mathematics. It could be explained that the use of Concentric teaching approach as emphasized in the theoretical frame work engages learners, makes

The enhancement of mathematics achievement by Concentric Teaching Approach could also be attributed to the fact that Concentric Teaching Approach exposed students' area of difficulties and with the difficulties noted, students charted out new plans for integrating knowledge into memory as they monitor their progress in learning the new concepts. Concentric teaching approach is valuable and improved students academic performance because it also



addresses the diverse learning needs of students and facilitates a gradual progression through the scheme of work or curriculum. In similar manner like other innovative student centered methods of teaching, concentric teaching approach entail sequential structure which allows students to solidify their understanding of topics at each stage, reducing the likelihood of knowledge gaps.

The findings of this study agree with that of Emmanuel, Irenc, and Charles (2021) and Amalija (2018), whose studies confirmed that students' centred teaching approaches lead to students improved performances in mathematics. Similar results were also held in related studies by Onwuka (2015), Tutkun and Ozturk (2013).

This study finding also revealed that gender has no significant effect on the academic performance of students in mathematics (geometry) when taught concentric teaching approach. This finding on gender agrees with the earlier findings of Danjuma (2015) who found that gender has no significant influence on students achievement in mathematics. It is also in line with the finding of Olanrewaju, Bettet and Ugwuanyi (2016) who reported that gender has no significant influence on students achievement in mathematics. Other studies that revealed no significance to issue of gender difference include Muhammad (2017), who revealed that there was no significant gender difference in student's performance in mathematics. The finding of the study on academic performance is also in line with the findings of Hayatu and Okoronka (2016) that gender was not a significant factor in students' performance in mathematics word problems in Mubi metropolis in Adamawa State.

The implication of this finding could be that what matters in teaching and learning is the effectiveness of the instructional strategy. Accordingly, once an instructional strategy is motivating and engages students' attention, it does not discriminate in the performance of males and females. The findings of the study, however, contravene the findings of Gupta, Pasrija and Kavita (2015) that gender has significant effect on students' academic achievement when taught mathematics using problem solving ability on academic achievement of high school students in Rohtak Distric India as female students showed higher mean gain score compare to their male counterpart. A contradicting result was however found by Oluwatelure (2015), who revealed that there was a significant sex difference in the performance of students in science.

Conclusion

The use of the concentric teaching approach in teaching mathematics (geometry) concepts facilitated students' performance in geometry better than the use of conventional method. The gender difference among students exposed to concentric teaching approach was not significant implying that concentric teaching approach is capable of facilitating learning in similar manner among male and female students in mathematics.

Recommendations

The following recommendation was made based on the findings and conclusion of the study.

1. Mathematics teachers should adopt concentric teaching approach in order to cognitively engage students in the learning process and help them integrate previous knowledge into learning new mathematical concepts.

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