EFFECT OF EXPOSITORY ADVANCE COGNITIVE ORGANIZER ON SENIOR SECONDARY SCHOOL STUDENTS' ACHIEVEMENT IN MATHEMATICS IN ENUGU EAST L. G. A. ENUGU STATE, NIGERIA.

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Abstract

The consistent poor achievement of students in Mathematics has continued to generate reactions from both the government and stakeholders in education sector. Against this background, several efforts have been made to find solutions to the problem. It is on this note that this study investigated effect of expository advance cognitive organizer on senior secondary school students' achievement in Mathematics in Enugu East L. G. A. Enugu State, Nigeria. The study has two research questions and three research hypotheses. It adopted a non-equivalent control group quasi-experimental research design. The sample size for this study was 157 which was made up 59 males and 98 females. Out of the 10 public secondary schools in Enugu East L.G.A., five are co-educational schools and two schools were randomly chosen from the five schools. In each of the two schools sampled, two intact classes were randomly selected and used for the study. The instrument used for data collection was Circle Geometry Achievement Test (CGAT). The reliability coefficient of the CGAT was determined to be 0.75 using K-R 20 formula. The instrument was administered to the students before the treatment and after the treatment. The research questions were answered with mean and standard deviation while the hypotheses were tested with ANCOVA probability level of .05. After the data analysis, the following findings were made: students taught circle geometry with expository advance cognitive organizer achieved better than the students taught with traditional method; there is no significant difference between the mean scores of male and female students with expository advance cognitive organizer. Based on the findings, the researcher recommended that, in addition to organizing conferences for in-service Mathematics teachers; seminars and workshops should be organized by the school board for Mathematics teachers on how to use advance cognitive organizers in teaching Mathematics.

Keywords: Expository Cognitive Organizers, students' achievement and gender.

Introduction

Education is a veritable tool for the development of the potentials of human beings. In the world of today, ruled by technological and scientific advancement, the study of science subjects is gradually taking the center stage of all academic struggles. Mathematics, which is referred to as the queen of all science, (Anaduaka and Okafor, 2013) is the bedrock of all the technological and scientific developments. Mathematics as a discipline deals with the logic of shape, quantity and arrangement (Elaine, 2013). In other words, it is an abstract science of numbers, quantity and space. Odili (2006) stated that Mathematics is a body of knowledge, a collection of techniques and

methods, and the product of human activity. Thus, Mathematics is a discipline that seeks understanding of patterns and structures of constructs of the human mind. It is seen by society as the foundation of scientific and technological knowledge that is vital in the socio- economic development of the nation. Because of this, Mathematics is a compulsory subject at both primary and secondary school levels in Nigeria.

Mathematics is also used as a basic entry requirement into any of the prestigious courses in tertiary institution such as Medicine, Architecture and Engineering among other degree programmes. Students with an interest in a subject like Mathematics are likely to be more motivated to manage their own learning and develop the requisite skills to become effective learners of that subject, (Anaduaka, Olaoyo & Sunday, 2018). Hence, interest in Mathematics is relevant when considering the development of effective learning strategies for Mathematics. In contrast, anxiety about learning Mathematics can act as a barrier to effective learning. Students who feel anxious about their ability to cope in Mathematics learning situations may avoid them and thus lose important career and life opportunities.

Despite the importance of Mathematics to societal development, it is a subject that many students fear, fail and possibly dislike (Ajani and Olabode, 2018). Mathematics has always been perceived as the most difficult subject in the school curriculum (Poopola and Ajani, 2011). This has resulted in learners having a negative attitude towards the subject and this attitude seems to have existed from one generation to another. For instance, the students' achievement in Mathematics over the years has not been encouraging. The West African Examination Council (WAEC) Annual Report, 2008 – 2017 as reported in Bello (2018), shown on the table below indicates a dwindling percentage on the achievement of students in Mathematics.

Table 1 - Nine Years Result Achievement of Students in Mathematics in SSCE, 2007 – 2015

Year	Number Examined	Distinction & Credit Pass	Percentage of Distinction and Credit Pass
2007	1 249 028	584 920	46.83
2008	1 268 213	726 398	57.28
2009	1 348 528	634 382	47.04
2010	1 306 535	548 065	41.95
2011	1 508 965	608 866	40.35
2012	1 658 357	838 879	50.58
2013	1 658 187	899 901	54.27
2014	1 632 377	1 011 584	61.97
2015	1 532 252	1 010 492	65.94

Source: (Bello 2018)

As can be seen from the table 1 above, although, there seems to be a continuous improvement on the achievement of students from 2011, yet thousands of students are still below credit pass in Mathematics. However, it can be observed that there is remarkable decline from 2009 to 2011, where the percentage credit pass came down from 47.04 to 40.35.

Meanwhile, a lot of factors have been attributed to be the causes of this poor performance. Some of the reported causes include, lack of understanding of basic mathematical principles (Bursal and Paznokas, 2006), poor teaching and learning environment and lack of modern equipment (Adegoke, 2013), poor mathematical ability of the students (Olatoye, 2007), students' poor attitude toward Mathematics, inadequate teaching/materials, lack of motivation of both teachers and students, ineffective instructional strategies, etc.

This poor achievement of the students in Mathematics have attracted the attention of many researchers (Anaeche, 2007; Azuka, 2012; Michael & Iyekekpolor 2013; Adeniji, 2014), to finding solutions to the problem. Often times, it is said that if the students have not learnt, the teacher has not taught. This statement makes it more imperative for teachers to be looking for avenues to improve the performance of students. Ulmer (2013) said that teachers are more and more being held accountable for the learning of both regular education students and those served in special

education. Thus, with the place of Mathematics in the life of every child, and the compulsion placed on it for every child by FGN (2013), teachers in general education must find appropriate instructional strategies to assist students with various deficiencies in their various subject areas.

In the light of the poor achievement of students in Mathematics over the years; and with the suspicion on ineffective instructional strategies, calls have been made by both federal and state governments, for immediate solution to improve the students' achievement, interest and retention in Mathematics. This will facilitate the much-needed technological breakthrough of Nigeria as well as qualitative education of the citizenry. Several researchers, *(Anaeche, 2007, Onoh, 2005, Azuka, 2009, Micheal & Iyekekpolor 2013, Adeniji, 2014),* have advocated for several strategies for improving the poor academic achievement of the students in the senior school examinations. The major strategies suggested in those researches include the use of Mathematics games, team teaching, problem solving strategies, motivational teaching strategies, peer instruction and assessment strategies, use of advance organizers, etc. One instructional tactic that has been cited in the literature as a more effective approach to addressing students' poor academic achievement, interest and retention in Mathematics is the use of advance cognitive organizers, (Mallick & Amandeep, 2014).

Advance cognitive organizer is a kind of cognitive bridge, which teachers use to help learners make a link between what they know and what is to be learnt. It is a cognitive strategy proposed by Ausubel in his Subsumption theory, which allows the learner to recall and transfer prior knowledge to the new information being presented, (Mostafa, 2017). The teacher plays the role of a lecturer or explainer. The lesson is to be organized in a way that pupils utilize the knowledge. The objective is achieved through strengthening the cognitive structure of the learner. Cognitive organizers have been employed by educators to help learners perceive information as a meaningful unit, i.e., understand that the material being taught is not merely unrelated words or

concepts (Horton, Lovitt, & Bergerund, 2010). Research has demonstrated the efficacy of organizers in teaching a variety of content areas *(Sturm & Rankin-Erickson, 2012; Boyle, 2009; Horton, Lovitt, & Bergerud, 2010; Griffin, Simmons, & Kane'enui, 2011; Bos & Anders, 2012; Boon, Fore, Ayres, & Spencer, 2015).* Cognitive organizers, originally referred to as advance organizers or structured overviews, were developed to help link a learner's prior knowledge to new meaning in a content area (Ausubel, 1978). Advance organizers can have a profound effect on students' success during a lesson, especially when that lesson requires them to receive, store, and recall new information.

Teachers can also refer to points established in the advance organizer throughout the lesson. With a narrative advance organizer, for example, the teacher might refer to parts of a story told to introduce the day's lesson. With an anticipation guide, students can check the accuracy of their anticipated responses while they listen to a lecture or view a video. Mostafa (2017) called it cognitive bridge, which teachers use to help learners make a link between what they know and what is to be learnt. Similarly, skimming advance organizer which is a preview of reading that will occur later in the lesson, paying special attention to headings, bold print, etc. This helps students to always recall the objectives of the lesson as the lesson progresses. Again, Onoh (2005) posited that demonstration advance organizers are concrete experiences that can be used to illustrate a mathematical concept, principle or point. To illustrate a concept, for instance, teachers should first state the concept and then parallel the statement with a demonstration that illustrates the idea. It is when an idea is arranged in this pattern that it is considered as advance organizer. In the same vein, comparative advance organizer shows the similarities and differences between the previous knowledge of the learners and the new content to be presented. A graphic organizer on its own, is a visual and graphic display that depicts the relationships between facts, terms, and ideas within a learning task. It is also referred to as knowledge maps, concept maps, story maps, cognitive

organizers, advance organizers, or concept diagrams (Strangman, Hall, & Meyer, 2003). For expository advance organizer, it is a description of a new concept to be presented, while highlighting the important contents in form of study questions of the lesson. This is why this study focused on determining the effect of expository advance cognitive organizer in senior secondary school two (SS2) students' achievement in Circle Geometry since there is a limited research in this topic.

Gender is another debatable factor which has connection with the achievement, interest and retention of students in Mathematics. It has generated a lot of concern for Mathematics educators. Ogunkule (2007) in Iyoke (2015) posited that despite the place of Mathematics in development and technological advancement of any nation, girls tend to run away from Mathematics. Etukodo (2012) showed that male students achieved significantly better than female counterparts when concept mapping is used in Algebra. Similarly, Idris and Momoh (2001) established in their study that there is significant difference in the achievement of boys and girls in both forms of Ahmadu Bello University Mathematics Test (ABUMAT). However, there are contradicting results on the influence of gender on Mathematics achievement, interest and retention of students. While Onoh (2005) has shown that gender has played no significant role in algebra, i.e. boys and girls achieved equally in performance; Udegbe (2005) asserted that female students achieved better than their male counterparts in Mathematics. Against these contradictions and conflicting results, it becomes pertinent to find out if there will be gender disparity in students' achievement, in circle geometry when expository advance cognitive organizer is used in teaching and learning of Mathematics. This is in recognition of what Ogunkule (2007) in Iyoke (2015) suggested that though there exist gender differences (sometimes in favour of male students), in Mathematics achievement, if students are taught with new approaches and strategies, the gender differences may be eradicated.

Statement of the Problem

Students' achievement in Mathematics has consistently been poor over the years. Many students find Mathematics boring and time wasting. As a result, many students are frustrated, distracted, and hence, lost interest in the subject, which affected achievement adversely. In the light of this situation, the nation is at the verge of collapsing if something urgent is not done to ameliorate this poor achievement. This poor achievement becomes so worrisome in this present-day world, ruled by science and technology. It would be noted that, at least a credit pass is required of the students to gain admission into tertiary levels of education to study any course of their choice.

Several reports have noted that students' achievement, interest and retention are closely related to the effectiveness of the strategies the teachers use, especially in Mathematics class. Such strategies as the use of Mathematics games, team teaching, problem solving strategies, motivational teaching strategies, peer instruction and assessment strategies, use of advance organizers, etc. have been advocated for. But there is limited study on the efficacy of the use of expository advance cognitive organizer for the improvement of students' academic achievement, in Mathematics in Enugu East L. G. A. In essence, the study sought to answer the questions of whether the use of expository advance cognitive organizer will have any effect on the achievement of the students and if there is any gender effect on students' Mathematics achievement.

Purpose of the Study

The main purpose of this study was to find out the effect of expository advance cognitive organizer (EACO) on senior secondary school students' achievement in Circle Geometry in Enugu East L. G. A, Enugu State. Specifically, the study sought to find out the:

1. mean achievement scores of senior secondary two (SS2) students in Circle Geometry when taught with expository advance cognitive organizer (EACO) and those taught with traditional method.

2. mean achievement scores of male and female SS2 students when taught Circle Geometry with EACO and those taught with traditional method.

Research Question

The researcher formulated the following research questions that guided the study:

1. What are the mean achievement scores of SS2 students taught Circle Geometry using expository advance cognitive organizers (EACO) and those taught with traditional method?

2. What are the mean achievement scores of male and female SS2 students taught Circle Geometry with EACO?

Research Hypotheses

The researcher formulated the following research hypotheses to further guide the study. The hypotheses were tested at 0.05 probability level.

1. There is no significant difference between the mean achievement scores of senior secondary two (SS2) students in Circle Geometry when taught with expository advance cognitive organizer (EACO) and those taught with traditional method as measured by Post Circle Geometry Achievement Test (POSTCGAT)
2. There is no significant difference between the mean achievement scores of male and female SS2 students when taught Circle Geometry with EACO and those taught with traditional method as measured by POSTCGAT.

3. There is no significant interaction effect of method and gender on the mean achievement scores of students as measured by POSTCGAT.

Methodology

The research design adopted for this study was non-equivalent control group quasi-experimental research design. This design was considered because the subjects for this study were not randomized. Intact classes, randomly assigned to treatment and control groups, were used. Ali (1996) commented that in quasi-experimental design where non-equivalent groups will be used due to non-randomization of subjects, a pretest should be administered at the beginning of the study. The pretest was used for finding out homogeneity or otherwise of the groups. The study was conducted in public secondary schools in Enugu East L. G. A, Enugu State. Enugu East local government area has a total of one thousand seven hundred and seventy-six (1776) SS2 students which is made up of 736 males and 1040 females. The sample size for this study was 157 which was made up 59 males and 98 females. Out of the 10 public secondary schools in Enugu East L.G.A., five are co-educational schools and two schools were randomly chosen from the five schools. In each of the two schools sampled, two intact classes were randomly selected and used for the study. The instrument used for data collection was Circle Geometry Achievement Test (CGAT). The instruments were subjected to expertise validation and was adjudged, after corrections, to be valid. The reliability coefficient of the CGAT was determined to be 0.75 using K-R 20 formula. The instrument was administered to the students before the treatment and after the treatment. The researcher developed expository advance cognitive organizer for the treatment group. This was incorporated in the lesson lessen plan prepared by the researcher for the regular Mathematics teachers who served as the research assistants. The research questions were answered using mean (X) score. The decision as high achievement was based on any mean score that was 50% and above in CGAT. While low was on mean score that was below 50%. Hypotheses were tested at 0.05 probability level using multiple analysis of covariance (ANCOVA). ANCOVA was

considered appropriate since intact classes were used. It was meant to take care of the initial differences in performance of the students across the groups, in the pretest, which served as the covariate to the posttest. This left only the residuals or adjusted scores so that the researcher can validly determine the significant difference in the pretest and posttest (Uzoagulu, 2017). The decision rule was to reject HO if probability value is less than the significant level, otherwise, fail to reject.

Data Analysis, Result and Discussion

Research question 1: What are the mean achievement scores of SS2 students taught Circle Geometry using expository advance cognitive organizers (EACO) and those taught with traditional method?

Table 2: Mean and S.D Score of treatment and control groups in pretest and posttest

Group	Pre-test		Post test		Mean (x)difference within the groups
	Mean (x)	S.D.	Mean (x)	S.D.	
Expr. (n= 78)	18.6282	4.97816	33.5000	2.34521	14.8718
Control (n= 79)	15.9241	3.62602	21.6076	2.81670	5.6835
Mean (x) different between the groups.	2.7041		11.8924		

Table 2 revealed the results of CGAT administered on the students. It could be observed from the table that the treatment group, taught circle geometry with expository advance cognitive organizers, had a mean score of 18.62 with a S.D. of 4.98 in the pretest, while the control group taught with traditional method had a mean score of 15.92 with a S.D. of 3.63. Similarly, in the posttest, experimental group had a mean of 33.50 with a S.D. of 2.35 while the control group taught with traditional approach had a mean of 21.61 with a S.D. of 2.82. The mean difference between the groups in pretest is 2.70. However, the difference within the pretest and posttest groups for the experimental group is 14.87 and 5.68 for the control. Therefore, there was a great difference in the

mean achievement of students taught circle geometry using expository advance cognitive organizers, and those taught using traditional approach. Obviously use of expository advance cognitive organizers is more effective in improving students' achievement in Mathematics.

Research Question 2: What are the mean achievement scores of male and female SS2 students taught Circle Geometry with EACO?

Table 3: Mean **(x)** achievement scores and S.D. of Males and Females in Treatment group

Gender	No	Mean (x)	S.D
Male	30	33.333	2.52345
Female	48	33.6042	2.24783
Total	78	33.500	2.34521
Difference in mean		0.2712	

Table 3 revealed achievement scores of males and females in treatment group. The male students taught circle geometry using expository advance cognitive organizer have a mean of 33.33 with a S.D. of 2.52 while their female counterpart had a mean score of 33.60 with a S.D. of 2.25. The mean difference between the male and female students is 0.27 in favour of the females.

Table 4: Analysis of covariance (ANCOVA) for hypotheses 1, 2 and 3 on students Achievement

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Decision
Corrected Model	5552.851[a]	3	1850.950	272.209	.000	
Intercept	111776.026	1	111776.026	16438.300	.000	
Method	5158.132	1	5158.132	758.579	.000	S*
Gender	.069	1	.069	.010	.920	NS*
Method * Gender	1.905	1	1.905	.280	.597	NS*
Error	1040.359	153	6.800			
Total	125462.000	157				
Corrected Total	6593.210	156				

S* = significant at p $\leq$.05 level of sig.; NS* = not significant at P $\leq$ .05 level of sig.

Table 4 revealed the ANCOVA results of students who were taught circle geometry with expository advance cognitive organizer instructional method and traditional method. In the table, method has F value of 758.579 and significant at .000. This significant value of .000 is less than.05

(i.e. .000≤ P ≤ .05). Therefore, F is significant at .05. Hence, the hypothesis one is rejected. This means that there is significant difference between the mean achievement scores of students taught circle geometry with expository advance cognitive organizer and those taught with traditional method. More so, gender has F value of 0.010 and significant at .920. This significant value of .920 is greater than. .05. Therefore, F is not significant at.05. Hence, the hypothesis two is not rejected. That is, there is no significant difference between the mean achievement test scores of male and female students taught circle geometry with expository advance cognitive organizer instructional method. Similarly, method and gender have F value of .280 and significant at .597. This significant value of .597 is greater than .05. Therefore, F is not significant at .05. Hence, the hypothesis three is not rejected. That is, there is no interaction effect of method and gender on the mean achievement scores of students as measured by POSTCGAT.

Discussion

Based on the findings in this study, there is an indication that the problem of poor achievement of students in Mathematics among senior secondary school students can be solved through effective method of instruction. That is, such methods that are students oriented. It is very obvious that use of advance cognitive organizers, especially, expository advance organizers, is an example of such method. This was clearly shown by the mean score of 33.50 of student taught circle geometry as against the mean score of 21.61 of students taught with traditional method. There is a high mean gain of 11.89. The result of this study agrees with the call for modern educationist for the use of students' oriented methods of instruction. Furthermore, the result upholds the earlier findings of Unodiaku (2018), that the use of origami-based instructional model approach, which is a student oriented approach of instruction, is effective in teaching geometry and mensuration aspects of Mathematics.

The result of this study revealed that there is a difference in the mean achievement scores of male and female students taught circle geometry with EACO, in favour of females. That is, female students had a mean of 0.27 more than the males. This implies that the use of expository advance cognitive organizer favours female more than the males. However, the mean difference was not significant at .05. This result upholds the findings of Onoh (2005), that females achieved better than males when taught with demonstration advance cognitive organizer, but the mean difference was not significant. In the same way, this result affirms the findings of Anaduaka, Sunday and Olaoye (2018), that is no significant difference in the Mathematics achievement of male and female attention-deficit hyperactive junior secondary school students taught with Think-Pair-Share cooperative instruction. This Think-Pair-Share cooperative instruction is a student oriented approach to Mathematics learning. On the other hand, the result of this study, contradicts the findings of previous researchers (Hydea and Merzb, 2009; Ozofor, 2001; an Unodiaku, 2013)**,** that females performed better than males in Mathematics achievement. In contrast, some other studies earlier conducted reported that boys performed better than girls in Mathematics achievement tests (Fennema, 2010; Muthukrishna, 2010; Asante, 2010; and Olasunde and Olaleye, 2010). These inconsistency reports suggest the need for further enquiring to clarify the differences.

Conclusion

Based on the findings of this study, it can be concluded that the use of expository advance cognitive organizer in Mathematics instruction increases the achievement of senior secondary school students in Mathematics. This instructional approach (EACO) favours female students more than the males but there is no significant difference between the mean achievement scores of male and female students. This implies that the use of expository advance cognitive organizer can bridge the gap between male and female students' performance in Mathematics achievement tests.

Recommendation

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

- The curriculum planners should emphasize, in the curriculum document, the use of advance cognitive organizers in secondary school Mathematics instruction. This will help to reduce mathemaphobia among the students.
- Conferences, seminars and workshops should be organized by the post primary school management board for the Mathematics teachers on how to use advance cognitive organizers in classroom instruction.
- The use of advance cognitive organizers should be encouraged by the authorities of Colleges of education during teacher training programmes. This will help the would-be teachers to master its use before graduation.

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