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**Research Paper**

# Enhancing mathematics achievement of introverted and extroverted secondary school students through the use of advance organizers

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***Abstract.*** This research investigated the effect of the use of advance organizers on academic achievement of introverted and extroverted students in mathematics in Senior Secondary Schools (SSS) in Awka South Local Government Area of Anambra State, Nigeria. Two research questions and two research null hypotheses guided the study. Quasi-experimental design, specifically pretest–posttest nonrandomized control group was adopted. The sample was made up of 71 SSS 2 students randomly selected from two schools using intact classes. There were 22 extroverts and 17 introverts in the experimental group and 18 extroverts and 14 introverts in the control group from the two schools were identified using personality inventory. The experimental group was exposed to the use of advance organizers while the control group was not exposed to it but was taught using modified lecture method. The mean and standard deviation were used to answer the research questions while the Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 levels of significance. Findings from the results revealed that students taught mathematics using advance organizer achieved higher than those taught without it. There was significant difference between the mean achievement scores of students in the two groups in favour of experimental group. Extroverts achieved slightly higher than introverts taught with advance organizers but the difference was not significant. The study recommended that student mathematics teachers should be exposed to the use of advance organizers in teaching mathematics by their lecturers in the method class.

**Keywords:** Venn diagram, K-W-L chart, mathematics teachers, Awka South, Nigeria.

## INTRODUCTION

Mathematics is a conglomeration of several subjects; arithmetic, algebra, geometry, calculus, statistics, mathematical modeling, number system and so on. Alio et al. (2009) viewed mathematics as a model of thinking and developing scientific structure for drawing conclusions. Like many countries in the world, the education system in Nigeria places strong emphasis on the subject - mathematics. This is because nations that are deemed to be developed and largely considered as civilized have achieved that status through purposeful and strategic scientific education of their citizen (Ndirikaet al., 2011).

The indispensible nature of mathematics in relation to many other disciplines explains why in Nigeria and most countries today, it is regarded as a core subject in primary, secondary and tertiary schools. The increasing importance and attention given to mathematics stem from the fact that it is regarded as the backbone of any scientific development of a nation or society; without mathematics there is no modern technology and without modern technology there is no modern society (Okeke and Okeke, 2011).

In addition, mathematics is recognized as ideally suited to preparing the mind for higher forms of thought because of its nature in dealing with visual things on one side and with abstraction on the other side. It is taught to children not only because of social and economic usefulness, but because of its impact on the individuals. However, the state of mathematics education in Nigeria turns out to be a source of worry to Nigerian citizens because students' performance in the subject is too poor to meet up with the vital role of mathematics. Available examination results in mathematics (WAEC Annual Reports, 2006 - 2014) from Nigeria revealed that greater percentage of students perform below average in mathematics in SSCE. There has been a national outcry by parents, educators, persons, educational administrators and the government on this matter.

The causes of poor performance in senior secondary school mathematics have been blamed on different factors. Researchers (Harbor-Peters, 2001; Okigbo, 2010) associated students' poor performance to teachers' poor teaching method. Yet, Amazigo (2000), Ogunkunle (2004), and Okigbo and Okeke (2011) faulted lack of qualified and experienced mathematics teachers among other variables. However, the way the teacher presents a topic or lesson will go a long way in determining the achievement of the students in that lesson. For better achievement, the teacher should begin from known to unknown. This calls for the use of certain ingredients in the classroom like advance organizers. Advance organizer is an information that is presented prior to learning and that can be used by the learner to organize and interpret new incoming information (Mayer, 2003; Okigbo, 2010; Okigbo and Okeke, 2013a; Onwioduokit and Akinbobola, 2005). It generally refers to concepts or principles that are more general, inclusive and stimulating than those in the actual learning materials. It is also an initial statement about a structure for the new information and relates it to information that students already possess. It is introduced in the form of a topic which contains ideas with which the learner will have some familiarity. It provides cognitive bridges or links for binding together both existing and new knowledge. The present research is anchored on Ausubel (1960, 1962) theory of meaningful learning which states that when a new concept links to an existing one, this new concept links becomes meaningful to the learner, which means that she/he has learnt the new concept.

Advance organizer was developed to orient students to materials they were about to learn and to help them recall related information that could be used to assist in incorporating the new material. It involves the use of graphics, questions, and networking, outlining to stimulate and help students to learn. This study focused on the use of graphic organizer (Venn diagram and K-W-L chart) and instructional analogy as advanced organizer in teaching some mathematics concepts to extroverts and introverts in senior secondary school mathematics class-rooms. Graphic organizer is a method of presenting information in the visual realm. It is efficient because it highlights and focuses on just the important aspects and show relationships between necessary information. Examples include; Venn diagram, K-W-L chart, concept mapping, and so on. Venn diagrams were introduced in 1880 by John Venn (1834 - 1923) which he referred to as a diagram representing mathematical or logical sets pictorially inside circles or closed curves within an enclosed rectangle and common elements of the sets being represented by intersections of the circles. The K-W-L Chart involves three steps which are: What the learner already knows about the subject matter (K), what the learner wants to know about the subject matter (W) and what the learner learned (L). More so, instructional analogy is seen by Okigbo and Okeke (2013b) as instances in instruction in which some less familiar domains or abstract mathematics concepts are made more understandable to the learner by making references to similar mathematical relations, objects or situations with which the learner is familiar with. Experienced teachers often observe that some students always want to show that they have the knowledge of the topic introduced (Igbojinwaekwu et al. in Igbojinwaekwu, 2009). At the slightest attempt to test the entry behaviour of the students by the teachers, these students are often seen clearly raising their hands to answer questions. To them, any other questions raised by another group of students are regarded as unnecessary. Most times, they appear to be very interested in what goes on in the classroom or their environment. This category of students is called extroverts. Extrovert, according to Igbojinwaekwu (2009) is any person who seeks excitement in the external environment. On the other hand, there exist some students that appear not to know anything about the topic introduced by the teacher in the classroom. Whenever the teacher asks a question, they don't respond, until demanded by the teacher to do so. They appear to the teacher as students who do not have interest in whatever goes on in the classroom. This group is referred to as the introverts. Inexperienced teachers and at times experienced teachers find it difficult to cope with the process of teaching the two groups of students in the same classroom. In most situations, teachers, especially the experienced ones, tend to work with the extroverted students because they feel that these students make their work easier and more interesting to the detriment of the introverted students, who in most cases, appear to be passive.

In recent times, the growing hatred for mathematics is alarming and if the situation is not brought to a halt, the result may ultimately bring hindrance to the country's future scientific development. Most students especially in the senior secondary school see mathematics as abstract and do not seem to clearly understand mathematics concepts. They came to class with concepts that are sometimes wrong and there is need for the mathematics

teachers to introduce aids like organizers before the lesson to serve as anchors and help in correcting such pre-concepts or alternative concepts. The problem is 'could the use of advance organizers in teaching and learning of mathematics improve the achievement of extroverts more than introverts?'To provide possible answers to this question prompted the research.

**Purpose of the study**

1. Investigate the extent to which the use of advance organizers in teaching Senior Secondary School (SSS) mathematics will enhance the achievement of students.
2. Compare the achievement of extroverts and introverts taught mathematics with advance organizers.

**Research questions**

1. To what extent does the use of advance organizers in teaching enhance the achievement of mathematics students?
2. How do the mean achievement scores of extroverts and introverts taught mathematics with advance organizers compare?

**Hypotheses**

Two null hypotheses were tested at 0.05 levels of significance:

1. There is no significant difference between the mean achievement scores of students taught mathematics with advance organizers and those taught without it.
2. Extroverted and introverted students exposed to the use of advance organizers do not differ significantly in their mean mathematics achievement scores.

**MATERIALS AND METHODS**

The study adopted a pre-test and post-test nonrandomized control group design involving two intact classes. The population comprised of all the SS 2 mathematics students in the 18 public secondary schools in Awka South Local Government Area of Anambra State, Nigeria. A total of 71 students from two secondary schools were involved in the research. These two schools were randomly drawn from the 18 schools in Awka South. Two arms of 39 and 32 SS 2 students were randomly selected from two schools. One intact class was randomly assigned to the experimental group while the other was assigned to control group. A personality inventory was used in identifying the extroverts and introverts in the two groups. The experimental group had 22 extroverts and 17 introverts while the control group comprised 18 extroverts and 14 introverts.

**Instruments and validation**

Two instruments were used in this study. They are: Mathematics Achievement Test (MAT) and Personality Inventory (PI). Three instructional tools (instructional graphic organizers, instructional analogy and lesson plan) were also prepared.

***MAT***

The MAT is a 20-item objective question compiled by the researchers from SSCE mathematics past question papers based on the topics (theory of sets, fractions and linear equations) chosen for this study. The same MAT was used for pretest and posttest treatment but the colour of the paper for posttest was changed from white to blue and the items also reshuffled. The validity of the items was assessed by two mathematics education experts and one experienced secondary school mathematics teacher. The instrument was trial tested with an intact class of 25 students in a school not participating in the study but within the same area of study. After validation, the Kunder Richardson formula 20 was used to establish the coefficient of internal consistency for MAT and the value is 0.88.

***PI***

The PI is a 30-item instrument constructed by the researchers and used to identify the introverts and extroverts in the two intact classes. This was validated by three experts; two in educational psychology and one in guidance and counseling. The Cronbach alpha technique was used to establish the reliability of the PI and the coefficient of internal consistency was found to be 0.83.

The materials for teaching the students are the structured instructional graphic organizer, analogy teaching plan and lesson plan. The structured instructional graphic organizer and analogy teaching plan integrated Venn diagrams, K-W-L charts and analogies into lesson plan and was used to teach the participants in the experimental group. However, ordinary lesson plan used in conventional classroom was used for teaching the control group.

**Research procedure**

Before treatment started, the first researcher administered the personality inventory to the participants in both groups. This was assessed and used to identify

**Table 1.** Mean mathematics achievement scores of experimental and control groups.

| Group | Mean pretest | Mean posttest | Mean gain |
|---|---|---|---|
| Experimental (n = 39) | 32.69 (δ = 12.98) | 48.33 (δ = 16.62) | 15.64 |
| Control (n = 32) | 33.13 (δ = 16.76) | 42.97 (δ = 16.95) | 9.84 |
| Mean difference | -0.44 | 5.36 | 5.80 |

**Table 2.** Mean mathematics achievement scores of extroverts and introverts in experimental group.

| Group | Mean pretest | Mean posttest | Mean gain |
|---|---|---|---|
| Extroverts (n = 17) | 32.50 (δ = 11.94) | 48.41 (δ = 16.54) | 15.91 |
| Introverts (n = 22) | 32.94 (δ = 14.25) | 48.24 (δ = 16.71) | 15.30 |
| Mean difference | -0.44 | 0.17 | 0.61 |

the introverts and extroverts in the two groups, though both were taught in the same class. The MAT was administered to the two groups before the treatment as pretest by the same first researcher and the results were obtained.

The second researcher taught experimental group (n = 39) theory of sets, fractions and linear equations using the structured instructional graphic organizer and analogy teaching plan that integrated Venn diagrams, K-W-L charts and analogies into lesson plan. The control group was also taught the same topics by the same researcher with modified lecture method using ordinary lesson plan. Thus, the teaching in both groups was done concurrently by the same researcher; this helped in controlling teacher variable. To solve the problem of interclass discussion among the students, only one intact class in each school was used. The experiment also lasted for four weeks and it was expected that this period was long enough as not to permit the pretest to affect the posttest scores.

In addition, the posttest was administered by the third researcher immediately after the teaching (treatment period). This helped to disabuse the mind of the students that were been examined. The posttest lasted for 1 h 30 min which was collected and marked by the third researcher and the posttest results were obtained.

### Data analysis

The data collected were analyzed using mean, standard deviation and Analysis of Covariance (ANCOVA).

## RESULTS

**Research question 1:** To what extent does the use of advance organizers in teaching enhance the achievement of mathematics students?

Data on Table 1 show that the gain in achievement of students in experimental group is 15.64 while that of the control group is 9.84 with mean difference of 5.80. Hence, the use of advance organizers enhances achievement more but also increased the homogeneity of the individual score more.

**Research question 2:** How do the mean achievement scores of extroverts and introverts taught mathematics with advance organizers compare?

**Hypotheses 1:** There is no significant difference between the mean achievement scores of students taught mathematics with advance organizer and those taught without it.

Table 2 reveals a mean gain in achievement of extroverts to be 15.91 while that of the introverts is 15.30 with mean difference of 0.61. Thus, the use of advance organizers enhances achievement of extroverts and introverts almost equally.

From Table 3, a significant main effect was observed for teaching method with respect to post-achievement, $F(3,66) = 0.833$, $P = 0.04 < 0.05$. Therefore, the null hypothesis one is rejected. Thus, there is a significant difference between the mean achievement scores of students in experimental and control groups in favour of experimental group.

**Hypothesis 2:** Extroverted and introverted students exposed to the use of advance organizer do not differ significantly in their mean mathematics achievement scores.

Table 4 revealed that no significant main effect was observed for extroverted and introverted students with respect to post-achievement, $F(1, 36) = 0.021$, $P = 0.884 > 0.05$. Therefore, the null hypothesis of no significant difference is not rejected. Thus, non-significant difference exists between the mean achievement scores of extroverted and introverted students taught mathematics with advance organizer.

**Table 3.** Analysis of covariance test of significant difference between the two means.

| Source | Sum of squares | df | Mean square | F | Sig |
|---|---|---|---|---|---|
| Corrected model | 8297.01 | 4 | 2074.25 | 18.789 | .000 |
| Intercept | 106.04 | 1 | 106.04 | .961 | .331 |
| Posttest | 8286.89 | 1 | 8286.89 | 75.066 | .000 |
| Treatment groups | 275.92 | 3 | 91.97 | .833 | .040 |
| Error | 7286.088 | 66 | 110.40 | | |
| Total | 92375.00 | 71 | | | |
| Corrected total | 15583.10 | 70 | | | |

a. R Squared = .532 (Adjusted R Square = .504)

**Table 4.** The ANCOVA test of significant difference between the two means.

| Source | Sum of squares | df | Mean square | F | Sig |
|---|---|---|---|---|---|
| Corrected model | 2232.63 | 2 | 1116.31 | 9.218 | .001 |
| Intercept | 473.44 | 1 | 473.44 | 3.909 | .056 |
| Posttest | 2230.76 | 1 | 2230.76 | 18.420 | .000 |
| Extroverts and introverts | 2.60 | 1 | 2.60 | .021 | .884 |
| Error | 4359.68 | 36 | 121.10 | | |
| Total | 48275.00 | 39 | | | |
| Corrected total | 6592.31 | 38 | | | |

a. R Squared = .339 (Adjusted R Square = .302).

## DISCUSSION

The findings from Table 1 showed that the control group had higher mean pretest score than the experimental group. Yet the experimental group obtained a higher mean posttest than the control group with a mean difference of 5.80. Therefore, the experimental group performed better than the control group. To test whether the difference in means between the two groups is significant or not, hypothesis one was tested. The findings from Table 3 revealed a significant difference between the mean achievement scores of students in the experimental and control groups in favour of former group. The study thus attributed the difference in their achievement to the treatment given to the experimental group which was not given to the control group. This revealed that the use of advance organizers to certain mathematics topics enhance achievement more in those topics. This agrees with the findings of Iloputaife (2001), Onwioduokit and Akinbobola (2005), Anyamene and Anyachebelu (2009), and Okigbo and Okeke (2013 a, b), who revealed that the use of difference advance organizers in teaching some concepts in physics and mathematics significantly improve students' achievement in those concepts.

The findings from results in Table 2 showed that the extroverted students exposed to the use of advance organizers achieved slightly higher than introverted students exposed to the use of the same advance organizers with difference in mean gain of 0.61. In test for significant difference between the two means, hypothesis two was tested. Results from the test revealed a non significant difference in the mean achievement scores of extroverted and introverted students exposed to the use of advance organizers. Therefore, there was no significant difference between the mean achievement scores of the extroverted and introverted students exposed to experimental treatment. This finding agrees with that of Igbojinwaekwu (2009) who investigated on the academic achievements of extroverted and introverted students in senior secondary mathematics and revealed no significant academic achievement between the two groups. Though, from their mean gain score, only slight difference was observed in their mean gain score of 0.61, this may be as a result of the ability of extroverts to adapt to changes in the environment very fast.

### Conclusion

From the findings, the research concludes that the use of advance organizers in teaching mathematics (set theory, fraction and linear equation) enhances learning and it improves achievement of both extroverted and introverted students.

## RECOMMENDATIONS

The researcher gives the following recommendations:

1. Student mathematics teachers should be exposed to the use of advance organizers in teaching mathematics by their lecturers in their method class.
2. Government should adequately fund schools, and organize workshops and seminars where mathematics teachers should be trained on the use of advance organizers in teaching.
3. Teachers should put interest and continually learn more about advance organizers and ways of identifying introverts and extroverts in their classrooms.

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