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EFFECT OF MAPLE SKETCHPAD SOFTWARE ON SECONDARY SCHOOL STUDENTS' ACHIEVEMENT IN ALGEBRA IN ENUGU EDUCATION ZONE

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Abstract

The study investigated the effect of maple sketchpad software package on secondary school students' achievement in Algebra in Enugu Education Zone. two research questions guided the study and two null hypotheses were tested at 0.05 level of significance. The design of the study was quasi-experimental design. The specific design was the pretest posttest non equivalent control group design. The study was carried out among secondary schools in Enugu Education Zone of Enugu State. The population for the study consisted of 1,643 Mathematics students in the senior secondary two in the study area. The sample size was 360 drawn from Enugu East Local Government Area. The instrument for data collection was Algebraic Achievement Test (AAT). AAT was face validated by three experts in the Department of Mathematics and Computer Education. The reliability coefficient of the instrument was determined to be 0.73 using Kuder – Richardson Formula (K-R 20). The subjects were pretested before the treatment and the posttest was administered after the treatment, while the achievement test was administered two weeks after the termination of the treatments. The data collected were analyzed using the mean, standard deviation and ANCOVA. The findings of the study showed that students who were instructed and taught using Maple sketchpad performed better and achieve more than those taught using conventional method. It was also discovered that no particular gender was favored more by the treatment. Based on the findings of the student, it was recommended that secondary school Mathematics teachers should be given training on maple sketchpad so that they can use it while teaching. Also, seminars and workshops should be organized for serving teachers so as to acquaint them with the skill of maple sketchpad.

Introduction

Mathematics is defined as the science of quality and space (Tella, 2012). It remains the centre that holds all facets of life. Mathematics is a branch of knowledge that deals with numbers, qualities and skills, and it is the bedrock of all societal transformation and transfer of ideas into reality (Otum, Obasi and Ukpebor, 2009). It involves logical reasoning, drawing conclusion from assumed premises, systematized knowledge and or strategic reasoning based on accepted rules, laws or probabilities. It is the art which studies patterns for predictive purposes (Gilfeather and Regater, 2009).Mathematics as a school subject is recognized as the foundation of science and technology without which a nation could never become prosperous and economically independent (Mutari, 2013). Mathematics has continued to play central role in almost all sphere of life. It is generally utilized in the areas of medicine, engineering, Bio-sciences and other parameters for national development. Thus, mathematics is defined as the science of quality and space (Tella, 2012). It remains the centre that holds all facets of life.Due to the relevance of mathematics to National Development, the Federal Government of Nigeria made the teaching and learning of mathematics mandatory at all levels. For example, recently, the Federal Government of Nigeria presented a draft of mathematics education reform tagged "Mathematics Education for Change; Ministers Strategic Plan from 2015-2019". This is an attempt to improve the quality of mathematics education output. Article six (6) of the draft contains welfare for mathematics teachers and scholarships offer for exceptionally precocious students in mathematics for upper and lower basic classes. This is to enable Nigeria prepare secondary school students for responsibilities of citizenship, National development and radical change in mathematics education delivery which is imperative for 21st century knowledge-driven economy.

The school mathematics is basically made up of algebra, arithmetic and geometry at the secondary and tertiary levels. Algebra with its symbolic representation is the bedrock of all branches of mathematics. Algebra is a generalization of arithmetic in simple format using letters in symbols to represent numbers (Anyor, 2011). Mathematics process isproblem solving and all problems are involved into algebraic expressions and equations for a possible solution (Smith and Okoye, 2010). Algebra curriculum in secondary schools include (i) open sentences, (ii) simple equations in one variables, (iii) expansion of algebraic expression (iv) factorization (v) algebraic fractions (vi) word problems (vii) linear inequalities in one variable (viii) coordinate axis (ix) linear equations in two variables (x) linear graphs (xi) simultaneous linear equations (xii) change of subject (xiii) variation (Ogbu, 2011). Adeoye (2012) enumerated the objectives of algebraic expressions for teaching and learning to include (i) Hierarchy orderly approach (ii) creative imagination (tessellation) (iii) deductive thinking (extrapolation) and extension) (iv) problem solving (involving) (v) everyday arithmetic (existing).In general, the objectives of algebra in secondary schools are to: (i) introduce students to mathematical structure (orderly approach) (ii) introduce students to the understanding of the basic concepts (iii) evaluation of formulae and the solution of

simple equations (involving) (iv) introduce students to the meaning of useful basic algebraic concepts such as literal numbers, formulas and symbolic language of algebra (tessellation) existing and extrapolation (Basic Education in Mathematics, 2012).

Despite the importance of algebra in mathematics and other sciences like engineering, physics, medicine and National Development (Tella, 2012), secondary School students have continued to perform poorly in mathematics in general and algebra in particular. Sulieman and Hammed (2019) stated that one of the major problems facing the educational system in Nigeria is the abysmal failure of students in public examination; particularly at the secondary level of education. The situation is so pathetic that stakeholders keep on wondering why this level of education has persistently failed to meet the yearnings and aspirations of the society. Some researchers viewed strategy of teaching algebra as the problem of poor performance of algebra. A report from Ogunyemi and Adeoye in Okoro (2011) indicated that the four operations of addition, multiplication, subtraction and division and the failure to observe the rubrics, symbols, notations measurement units and inability to model mathematical word problems into algebraic expressions and equations for easy solution pose a problem to students' achievement in algebra.Challenged by the problem of improving students' achievement in algebra by ensuring sustainable scientific and technological development of the nation, mathematics educators have suggested various ways of improving the teaching and learning of algebra. Some of these researchers include Udeinya and Okabiach (2007) and Ekoya (2010). For example Johnson and Johnson in Anyor (2011) suggested cooperative and individualistic learning; Ogunyemi, (2012), algebra modeling. A comprehensive introduction Prentice Hall, Ibadan University Press in Popoola and Olarewaju (2010) suggested problem solving model as effective teaching and learning strategies. Odili in Smith (2014) stated that for mathematics students to perform well, he/she must be guided by psychological characteristics of how human beings learn.

These characteristics include cooperative attitudes, interest, hard work and commitment autonomous learning or independence and problem solving for students achievement.. Since the current paradigm shift is moving from teacher to learner-centered strategies, the above characteristics should guide the choice of teaching approach that will make success in algebra reach all students in Nigerian schools. Other researchers also noted that it is not certain whether mathematics teachers use effective teaching materials and instructional aids in the teaching of algebra in secondary schools.It is noted however that audio-visual aids may inspire students to exert maximal efforts toward achieving their goals (Egbo, Checko and Nwoke, 2011). This is because students learn more if they are engaged in significant and appealing activities (Joash, 2014). Regular instruction plus audio-visual aids resulted in more factual learning than those without audio-visual aids in mathematics (algebra) in secondary schools (Ogunyemi, 2012). Ogunyemi further stated that it is also noted that mathematics teachers who made use of appropriate instructional materials obtained higher mathematics scores.Instructional tools and materials are of immense importance to algebra achievement. The issue of motivation of students in the learning of algebra using

tools like Geogebra software, Laser Scan and Maple Sketch pad has dominated many researchers. For instance, Abimbode (2017) opined that instructional tools like geogebra and Maple sketch pad in teaching and learning of algebra promotes and sustains student's interest and helps the students to discover themselves and their abilities, and thus suggest the maple sketchpad for the teaching and learning of algebra.

Maple sketch pad is a mathematics and research software that combines powerful mathematics engine with an interface that makes it extremely easy to analyze, explore, visualize and solve mathematical (algebra) problems (Joash, 2014). Maple sketch pad is mathematical software that can function as an enhanced calculator, a programming language or as a tool to produce diagrams and graphs. Maple sketchpad is designed to release the students from routine work to allow them to focus on the essence of the student material at the moment consider more task to facilitate the understanding of algebra by other method of presentation. Maple sketchpad can facilitate the mathematical environment as it helps to relieve boredom and establish a friendly atmosphere which allows for growth of skills and knowledge (Joash, 2014). Many countries especially in West Africa have expended a lot of resources in the purchase of maple sketchpad for the teaching and learning of algebra. With maple sketchpad, students may be provided opportunities to see the algebra they have programmed in the sketchpad immediately and rapidly during instruction which will allow them to make immediate judgment and provide convincing argument about the validity of results in algebra for achievement and retention (Smith, 2014). With Maple sketchpad, students will find algebra as fun and interesting and teachers will find it easy to teach for students to achieve and retain. The pad allows students to manipulate objects and provides a visual model of conjectures or tests facilitating a search for pattern or generalization (Drier, 2010). Maple sketchpad in the teaching and learning of algebra will help to eliminate the major sources of frustration by students who do poorly because the subject requires a great deal of memorization regarding logical steps, sequences and number orders, those with bad memories often find themselves a loss when it comes to completing even the simplest algebra function.

Maple sketchpad is important in the teaching of algebra to secondary schools students and it helps both boys and girls who have phobia for algebra. Educators and researchers vary in their opinions as to whether gender affects students' achievement in secondary school mathematics (Algebra), or not. Gender is a cultural construct that distinguishes the roles, behaviours, mental and emotional characteristics between male and female developed by a society (Udousoro, 2011). Umoh (2003) defined gender as psychological term used in describing behaviours and attributes expected of individual. According to Nneji (2012), gender issues in sciences generally and mathematics in particular is indeed very vital. This becomes more obvious in societies such as ours where science is erroneously viewed as masculine and arts subject viewed as feminine. Abiam and Odok (2006) found no significant relationship between gender and teaching method on students' achievement in number and numeration, algebraic processes and statistics. Albert (2015) found that female students achieved higher than their male

counterparts in mathematics. In view of these contradicting results, this study investigated the effect of Maple Sketchpad software package on secondary school students' achievement in algebra. This study seeks to find which of the gender male of female benefitted more than the other in achievement and retention.

Purpose of the Study

The purpose of this study was to investigate the effect of maple sketchpad software on secondary school students' achievement in algebra in Enugu Education Zone of Enugu State.

Research Questions

The following research questions guided the study:

i. What are the mean algebra achievement scores of students in the experimental and control groups?
ii. What are the mean algebra achievement scores of male and female students in the experimental group?

Research Hypotheses

The following null hypotheses guided the study and they were tested at 0.05 level of significance.

I. **H_{O1}:** There is no significant difference between the mean algebra achievement scores of students in the experimental and control groups.
II. **H_{O3}:** There is no significant difference between the mean algebra achievement scores of male and female students in the experimental group.

Methodology

This study adopted a quasi-experimental research design. Quasi experimental design specifically pretest-posttest non-equivalent control design was utilized. Nworgu (2015) defined quasi-experimental research design as one which 'random assignment of subjects to experiment and control groups is not possible. The choice of the design according to Nwogbo (2007) is because there was no randomization of research subject into groups. This was to avoid disorganization of the school arrangement. Thus intact classes were used for the study. However, the intact classes were randomly assigned to either experimental or control groups. According to Nworgu in Okoro (2015), an essential and indispensable feature of quasi experimental design is the use of control group. He opined that a control group is one to which experimental treatment was not administered. A control group therefore usually provides the baseline against which to compare the effect of the experimental treatment on the experimental group. Expository method was used on the control group because it is traditional method used in all schools.

The teaching was for six (4) weeks. Each week had one contact period of 40 minutes duration. At the start of the experiment, all the students in the experimental groups were exposed to instructional technology. During subsequent meetings with the

students, the teacher also used instructional technology to teach them and each student was given a copy of the question stem, and the teacher encourages the students to write down questions relating to what they have been previously taught. For example, the topic is Algebraic Fraction (Algebraic process). Thus the use of Instructional technology can be used to teach.

Simplify $\frac{2}{x-1} = \frac{3}{x-2}$

Throughout the lesson for the experimental group questions were posed by the teacher at appropriate times (usually after sufficient content had been presented) for the students to consider. Later, the students also tried to answer the question by themselves. The students tried to solve some questions using Instructional technology devices which were used in the class to teach them. The repeated practice of making weekly tutorial reflections using some instructional technology devices in mathematics is expected to help students gain a sense of mastery in their learning. Students in the control group did not receive any instruction with instructional technology devices. At the end of four weeks, all the students was be tested on achievement test will be given two weeks after termination of treatment.The materials for teaching the students were the questions. The experiment group students were told that the use of instructional technology (Maple Sketch pad) and asking question is a way of managing and checking their achievement and that monitoring their learning would make them perform better in mathematics. The practice question sample or the generic question stem adopted from some questions in WABD Essential Mathematics for Senior Secondary School II and WAEC questions and modified by the researcher were distributed to all the students in the experimental group at the start of their lesson using instructional technology device.

The teachers lead the students on how to solve the questions by using the instructional technology devices to solve specific content related questions using some of the questions stems several times throughout the lesson each week. The teachers lead the students to solve algebraic questions using different sets of instructional technology and write out the answers as well. At the beginning of each week's lesson, students practice and discuss their answers with members of their small group. These mathematical questions form the basis of the renew of content proceeding each week's lesson by the teacher. The instrument for data collection was Algebraic Achievement Test (AAT).The AAT was adapted from the West African Examination Council (WAEC) past question papers and the items covered the content (algebraic process to be taught based on the period of task coverage). Initially, AAT was made up of 50 multiple choice questions with four options each (A, B, C and D). The instrument was divided into two sections. Section "A" of the achievement test elicited personal information from the students while section "B" was based on the questions on algebra. The AAT was administered as the pretest and the items were rearranged and then re-administered to the students as posttest after the treatment. The achievement test in algebra with the marking scheme, were given to three experts in the for face and content validation. Two of the experts were from Mathematics Education and one expert was in Measurement and Evaluation**.**

The reliability of the instrument (AAT) was established through a pilot study on 42 SS 2 students of new Estate Boys Secondary School, Maryland. The researcher computed the internal consistency of the instrument (AAT) using Kuder-Richardson formula (20). The choice of K-R (20) is influence by the fact that it is best used on multiple choice questions with right or wrong answer (Peters, 2016). The reliability coefficient obtained for AAT is 0.73.

Experimental Procedure

The treatment was conducted in the school classroom at the normal mathematics period. The treatment and testing was done by their regular class teachers. The pretest was administered before the experimental treatment. The posttest was given immediately after the treatment.The researcher organized one week training programme for the teachers that trained the students at about one week before the commencement of the actual teaching of the students.The teachers were involved in the study, that is, both control group and experimental group. Teachers were told to teach the same algebraic contents during the period.

Results

Research Question 1: What are the mean algebra achievement scores of students in the experimental and control groups?

Table 1: Mean Algebra Achievement Scores and Standard Deviations of students in the experimental and control groups in both Pre-test and Post-test

Groups	Number	Pre-test		Post-test	
		Mean ($\bar{x}$)	Standard Deviation (s)	Mean ($\bar{x}$)	Standard Deviation (s)
Experimental	174	26.24	4.88	38.37	5.91
Control	148	25.92	4.68	34.84	5.61

Data on Table 1 show that at pre-test, the achievement mean score for experimental group was 26.24 with a corresponding standard deviation of 4.88. After post-test, it was observed that for the experimental group, mean achievement score was 38.37. For the control group, at pre-test, the achievement mean score was 25.92 with a corresponding standard deviation of 4.68. After post-test, it was observed that for the control group, mean achievement score was 34.84. However, the standard deviation scores of the students in the Post test for the experimental group was 5.91 while for the control group it was 5.61, indicating that the students individual scores were more clustered around the

mean with expository method than with the Maple Sketchpad. This implies that students in the experimental group achieved higher than those in the control group considering their higher mean achievement scores at posttest.

Research Question 2: What are the mean algebra achievement scores of male and female students in the experimental group?

Table 2: Mean Algebra Achievement Scores and Standard Deviations of male and female students in the experimental group

Groups	N	Pre-test		Post-test	
		$(\bar{x})$	(s)	$(\bar{x})$	(s)
Experimental (Male)	73	26.45	4.77	39.55	6.02
Experimental (Female)	101	26.09	4.97	38.25	5.31

Data on Table 2 revealed that at pre-test, the mean achievement score for male students was 26.45 with a corresponding standard deviation of 4.77. Also, the female students mean score at pre-test was 26.09 and a standard deviation of 4.97 respectively. After post-test, it was observed that the male students' mean achievement score was 39.55 with a standard deviation of 6.02 respectively. For the female students at post-test, their mean achievement score was 38.25 with a corresponding standard deviation of 5.31 respectively. Similarly, the standard deviations for the male and female students after post-test are 6.02 and 5.31, indicating that the individual scores of the female students are more clustered around the mean than those of their male counterparts that had more extreme scores. This implied that the male students in the experimental group achieved higher than their female counterparts considering their higher mean achievement score at post-test.

Hypotheses

H_{O1}: There is no significant difference between the mean algebra achievement scores of students in the experimental and control groups.

Table 3:ANCOVA on the mean achievement scores of students in experimental and control groups

Tests of Between-Subjects Effects

Dependent Variable: ACHIEVEMENT

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	999.798[a]	1	999.798	30.249	.000
Intercept	428659.574	1	428659.574	12969.019	.000
GROUP	999.798	1	999.798	30.249	.000
Error	10576.826	320	33.053		
Total	446421.000	322			
Corrected Total	11576.624	321			

a. R Squared = .086 (Adjusted R Squared = .084)

Table 3 shows that the calculated F-value for the effect of treatment (method) on students' achievement in AAT is 30.249 significant at .000 level of significance, which is less than 0.05 set for the study. The null hypothesis is therefore rejected. This means that a significant difference exists in the mean achievement scores of mathematics students taught with maple sketchpad and those taught with expository method.

H_{O2}: There is no significant difference between the mean algebra retention scores of students in the experimental and control groups.

Table 4:ANCOVA on the mean achievement scores of male and female students in experimental group

Tests of Between-Subjects Effects

Dependent Variable: ACHIEVEMENT

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3.824[a]	1	3.824	.121	.728
Intercept	249899.962	1	249899.962	7914.497	.000
GENDER	3.824	1	3.824	.121	.728
Error	5430.894	172	31.575		
Total	261655.000	174			
Corrected Total	5434.718	173			

a. R Squared = .001 (Adjusted R Squared = -.005)

Table 4 shows that the calculated F-value for the effect of treatment (method) on gender in AAT is .121 significant at .728 level of significance, which is more than 0.05 set for the study. The null hypothesis is therefore not rejected. This means that a significant difference does not exist in the mean achievement scores of mathematics male and female students taught with maple sketchpad.

H_{O4}: There is no significant difference between the mean algebra achievement scores of male and female students in the experimental group.

Discussion

The discussion is presented under the following captions:

The findings of the study revealed that students in the experimental group achieved higher than those in the control group considering their higher mean achievement scores at posttest. Also, the students' individual scores were more clustered around the mean with expository method than with the Maple Sketchpad. The use of maple sketchpad in the classroom as a teaching method has a significant effect on student' achievement in the subject. The hypothesis revealed that there was a significant difference between the mean achievement scores of students in experimental group and those in control group. There was a difference between the post–test and pre-test scores for experimental and control groups respectively. This finding tends to suggest that the students trained in the use maple sketchpad as an instrumental technology did better than their counterparts.The summary of the result in table 1 reveal effect of maple sketchpad software on students in respect to experimental group achieved higher than those in the control group considering their higher mean achievement scores at posttest. Similarly in table 2 the male students in the experimental group achieved higher than their female counterparts considering their higher mean achievement score at post-test. Jucas (2012); Ruddak (2021) and Olaniyi (2015) sufficiently emphasized the fact that students learn more if they are engaged in significant and appealing activities. Therefore, the teachers should be encouraged to use maple sketchpad in the classrooms for teaching Algebra and other topics alike.

Recommendations

Based on the result of the study, the following recommendations were made.

1. Since this study has established the imperativeness of maple sketchpad in enhancing achievement and retention in algebra among student, the use of instructional technology should be incorporated in Nigerian school curriculum by the government.
2. Seminars and workshops should be organized by educator's federal and state ministries of education and related professional association and agencies who are charged of education, especially at the secondary level, to enable serving teachers to familiarize themselves with the use of maple sketchpad. Presently, many of the serving teachers are not familiar with this instructional technology.

3. Government and other professional associations should sponsor further research on the use of maple sketchpad in the teaching and learning on other subject area like physics, chemistry, biology among others.

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