Original Article

Innovative Pedagogical Approach on Students' Achievement and Retention in the Post Covid-19 Pandemic World in Senior Secondary School Mathematics in Enugu State, Nigeria

Ozomadu, E. A.[1] and Edeoga, B. O.[2]

1 Department of Science and Computer Education, Faculty of Education, Godfrey Okoye University Enugu, Nigeria

2. Department of science Education, Faculty of Education, Ebonyi State University, Abakiliki, Nigeria

Abstract

This study investigated creative pedagogical technique for senior secondary school student academic retention and success in Mathematics in the post Covid-19 pandemic world in Enugu State. The study used a quasi-experimental research design with non-equivalent controls, pre-tests, and post-tests. . The population of 34 312 (SS2) students used in the research. Using a simple random sampling approach, 395 students (230 males& 165 females) for the study. A geometry achievement exam and a geometry retention test were the study's testing methods. The data were evaluated with standard deviation and mean usage in order to respond to the study's queries and assess the hypotheses. When teaching mathematics, especially geometry, utilizing computer-assisted education, there is a considerable difference in both the students' achievement and their capacity to retain information. The researchers recommended that math instructors employ the CAI method, which was found to be more effective and gender-neutral, among other things, when instructing students in arithmetic in schools.

Keywords: Geometry, achievement, retention, and computer-assisted instruction.

Introduction

In Enugu state, Nigeria, mathematics teaching and learning in secondary schools has encountered several challenges over time. It is undeniable that Mathematics holds great significance, particularly at the grass roots level (primary and secondary schools). In Nigeria, students are required to obtain passing grades in Mathematics, English language, and four other subjects in other to gain admission into higher education institutions. Therefore, the acquisition of mathematical knowledge is crucial in any educational system that aims to equip its citizens for a successful life after completing their studies. . Abdul-Ganiyu (2014) submitted that the

contributions and applications of Mathematics to the progress of any nation's economic, scientific and technological development are enormous. For example, everyday situations lie calculating the amount of materials needed to construct a house or determining the quantity of fuel required for a journey are practical applications of Mathematics (Ojo,2015). However, despite the significance of Mathematics in the overall progress of any country, students consistently struggle with their achievement and retention of the subject. This is evident from the report released by the West African Examination Council's Chief Examiners (WAEC) in 2019 which highlighted that many students performed on the Senior School Certificate Examination (SSCE), below average. Additionally, Kurumeh,(2014) stated that students generally have a fear and dislike for Mathematics, leading to a lack of interest, poor performance and difficulty retaining knowledge, particularly in geometry and mensuration.

Numerous studies examined the causes behind such a low percentage accomplishment and retention, including inefficient teaching strategies and a dearth of teaching resources (Badmus, 2012; & Iji, 2015). Many teachers tend to continue with the traditional methods of instruction. Iji (2015) came to the conclusion that when a teacher modifies his ways to embrace a more student-centered approach, good things happen. The lecture method of instruction is frequently used by teachers at educational institutions. It involves the teacher vocally delivering knowledge to the students, who are essentially acting as passive recipients. According to this method, the instructor frequently writes on the chalkboard as the students observe, take notes, and ask clarifying questions (Kurumeh, 2014).

The Importance of using CAI in education cannot be underestimated as stated by (Gambari, Shittu & Taiwo, 2013) The authors highlight the numerous benefits of Computer-based instruction particularly in more advanced countries where researches have shown its instructional advantages. One of the most successful teaching methods for raising students' proficiency in Mathematics is called CAI. There are also numerous ICT-driven pedagogies accessible for various topic areas. In research carried out all around the world, it is evident that using computer tools and resources to enhance students' learning is the current trend (Gambari, Shittu, & Taiwo, 2013). They firmly

thought that the importance of mathematics makes it important for teachers to adopt cutting-edge pedagogical techniques to help students understand geometry in the digital age.

According to Isiaka, Ezenwa and Anyanwu, (2014), Computer-assisted instruction has been acknowledged as one of the most successful instructional approaches for increasing students' academic attainment and retention. Eze, Ezenwafor and Onwusa, (2020), looked at Computer – assisted instruction as an innovative approach to teaching and learning where the content is meticulously prepared, written, and programmed into a computer. This allows for simultaneous access and utilization of materials on multiple computer units.

Computer- assisted instruction program is also used to describe how computers can aid in teaching and learning. Various kinds of media, including text, images, audio, and video, are used in the CAI program to improve learning. These programs use solving problems, drills, and tutorials to convey geometry concepts and gauge comprehension by students.

The study of geometry focuses on the shape and structure of individual things as well as the spatial relationships between them and the properties of the space around them. The knowledge of Geometry is used in many fields such as engineering and crucial in understanding other branches of Mathematics and other school subjects. In spite of the articulated importance of geometry, there is evidence that the study is still dominated by expository method. Expository method is a technique dominated by teacher-centered approaches, when students receive information from an expert or authority on its subject. It is therefore, imperative to introduce innovative strategies that will bring about meaningful achievement and retention in geometry.

Studies that look at how different teaching approaches affect gender inequalities in students' Mathematics learning are still under controversy because they provide contradictory results, as mentioned by (Ajai & Imoko, 2015). Male and female pupils did not perform differently academically, according to Abakpa and Amo (2016). . Nonetheless, other investigations have discovered that pupils' cognitive, emotional, and physical skill successes are still significantly influenced by their gender (Aguele & Agwagah, 2018). According to Simpson (2015) understanding the impact of gender on learning Mathematics is not a straightforward matter. There

are various factors and contexts beyond gender that influence a child's ability to learn Mathematics. Kolawale (2007) found that, in terms of competitive learning strategies, boys outperformed girls in the academic success of Nigerian students in Mathematics. Furthermore, their research discovered a consistent trend where male students outperformed female students in science-related subjects.

Research conducted in Nigeria has shown that there has been a lack of emphasis on integrating ICT-driven teaching methods for Mathematics, notwithstanding the Federal Government of Nigeria's strong recommendations that make up the National Policy on Education (2004). Kanandjebo (2017) stated that despite significant researches, using innovative pedagogy in the teaching of Mathematics concepts, performance of students is very poor, especially in aspect of geometry. Therefore, there is the need for more call for the adoption of innovative pedagogical approaches in the use of Mathematics instruction to improve students' performance. If an innovative pedagogical approach like CAI is adopted in teaching Mathematics, what would be the effect on students' achievement in geometry?

Consequently, because of the inconsistent outcomes observed regarding gender's influence on students' poor performance and understanding of Mathematics, the researchers deemed it necessary to examine whether the implementation of CAI would address these identified gaps and provide opportunities for enhancing Mathematics proficiency and retention of students in Enugu state, Nigeria.

Statement of the Problem

Mathematicians, educators, and the general public have expressed worry about the persistently low achievement and retention in Mathematics. Although Mathematics is crucial for both individual and societal development, student achievement and retention have not been particularly encouraging. Poor achievement and retention in geometry may be caused by the instructional materials utilized in teaching and learning as well as the strategies used by mathematics teachers. This is so that the objective can never be accomplished if the methods are flawed and the materials are employed improperly. The conventional approach which has been found to be in use is not

helping matters because evidence from studies indicted conventional approach for the noticed poor proficiency and student retention in Mathematics. However, CAI a technological approach that has been developed for teaching and learning has to be researched upon.

Research Questions

The following research issues served as the study's guiding principles:

i. What are the average achievement scores of students who were taught mathematics using CAI compared to those who were taught using an expository approach?

ii. What are the retention rate of students who are taught mathematics using CAI and those who are taught using an expository approach?

Research Hypotheses

The following were the study's null hypotheses, which were assessed for significance at the 0.05 level:

i. students who learned Mathematics using CAI and those who learned using an expository approach did not have significantly different mean achievement scores.

ii. There are no appreciable differences between students taught Mathematics using the CAI approach and those taught using the expository approach in terms of mean retention scores.

Method

The study used a quasi-experimental pretest-posttest control group design that was non-randomized. This was taken into account because it was impossible to allocate group members at random, entire classes were used instead, and there was no class equivalency. In the design notation, non-equivalent selection below is a graph with the pre-test and post-test. Figure 1:

G1: $0_1 \rightarrow x_1 \rightarrow 0_2$

G2 $0_1 \rightarrow x_0 \rightarrow 0_2$

Key;

G1: Experimental Group one received pre-test 0_1 and treatment x_1, (CAI Mathematics Lesson), which later administered post-test 0_2.

G2: control group two received the same pre-test 0_1 and treatment x_0 (Expository approach) which after administered the same post-test (0_2) as in G1.

X1: Experimental treatment, x_0: No treatment in control group;

0_1: Pre-test,

0_2: Post-test,

The study's site was situated in Enugu state's Educational zone. There are 31 public secondary schools in the zone, which are dispersed throughout three local government areas. The state is located in the southeast of Nigeria and spans a total area of 7,162 km2.The population of the study was 34,312 SS2 students in Enugu State Education Zone ,during the 2018/2019 academic year (source: Statistics Department PPSMB Enugu Education Zone). 12,482 men and 21,830 women made up the population. 395 students from senior secondary school two (SS2), 230 of whom were male and 165 of whom were female, made up the study's sample. To choose the sampling process a multistage sampling procedure was adopted. A sample of nine intact classes from each of the three public secondary schools was randomly chosen from among the 31 public secondary schools in the Enugu Education Zone's, three Local Government Areas. The researchers used a geometry accomplishment test and a geometry retention test for their analysis. On these tests, there were 25 objective questions.

Three specialists validated the instruments. In addition to one measurement and evaluation specialist, there are two mathematics educators working in the department of science and computer education at Godfrey Okoye University in Enugu. The tests were then administered to 50 students from a different school from the ones being examined. The instrument's reliability was assessed using the Kudar-Richardson 20 (KR 20) method; the outcome was a reliability coefficient of 0.85.

Both groups underwent pretests to gauge their prior knowledge before to the experiment's start. After the experiment, a posttest was given to see how well the kids had learned geometry. The retention rate was calculated by re-asking the group the retention question four weeks later. The collected data were examined using metrics like mean and standard deviation to address the research issues, and analysis of covariance (ANCOVA) was performed to evaluate the hypotheses.

Results

The study's results are arranged and presented in this report in accordance with the research questions and hypotheses. Below is a discussion and exploration of the first research question.

Table 1 displays the Experimental and Control groups' mean scores and the Standard Deviation of achievement on the pre-test and post-test.

Group	No. of students	Pre-test		Post-test	
		Mean	SD	Mean	SD
Exp.	265	37.36	8.23	69.51	6.52
Control	130	37.41	8.34	61.07	4.94

The subjects in the experimental and control groups' mean scores and standard deviation on the Geometry Achievement Test (GAT) are shown in Table 1. The experimental group had a mean score of 69.51 with a standard deviation of 6.52 whereas the control group received a mean score of 61.07 with a standard deviation of 4.94. Before the test, the experimental group's mean achievement score was 37.36, whereas the control group's was 37.41; each group's standard deviation was 8.23. As a result, in the post-test, the experimental group fared 8.44 points better on average than the control group .The average recall rates of students who received arithmetic instruction through CAI as opposed to those who received it via expository instruction are the subject of the second study question.

For both the experimental and control groups, Table 2 shows the average and standard deviation of retention scores.

Group	Number		
		Mean	SD
Experimental	265	68.77	6.23
Control	130	61.9	4.33

The average and standard deviation of the retention scores for male and female students are summarized in table 4's data. Male students taught with CAI had an average retention score of

69.99 (with a standard deviation of 6.27), while female students taught with CAI had an average retention score of 68.74 (with a standard deviation of 6.71). This suggests that there is no significant difference in the mean retention scores between male and female students when considering the type of instructional materials used.

Hypothesis One: The mean achievement scores of students taught Mathematics with CAI do not differ significantly from those taught using an expository approach.

Table 3 presents the ANCOVA analyses conducted on Achievement scores of students

Source	Type111 sum of Squares	df	mean square	F	sig	Decision
Corrected model	6120.080[a]	6	1020.013	28.003	.000	S
Intercept	758533.390	1	7553.390	2082.452	.000	S
Covariate(pretest)	82.295	1	82.95	2.259	.134	NS
Group(method)	5986.176	2	2993.0888	82.171	.000	S
Gender	51.646	1	51.646	1.418	.234	NS
Group※ Gender	66.172		33.086	.908	.404	NS
Error	14132.917		36.425			
Total	1772166.000	395				
Corrected Total	20252.997	394				

Based on Table 3's findings, which show a significant difference in the average achievement score between students who received Mathematics instruction through CAI and those who received instruction using an expository approach, we can reject the assertion that no difference is statistically significant. The data also shows that when students are taught mathematics using a computer-assisted method, gender has no bearing on how well they succeed. The probability value of 0.234, which is higher than the significance level of 0.05, supports this? As a result, we can maintain a statistically meaningful influence on students' Mathematics achievement.

Hypothesis Two: There are no discernible differences in the retention rate between pupils taught mathematics using the CAI approach and those taught using the expository approach in terms of mean retention scores.

Source	Type111 sum of Squares	df	mean square	F	sig	Decision
Corrected model	4513.393[a]	6	752.232	23.792	.000	S
Intercept	74613.610	1	74613.610	2359.93	.000	S
Covariate	112.469	1	112.469	3.557	.000	NS
Group	4040.039	2	2020.020	63.891	.000	S
Gender	153.650	1	153.650	4.860	.028	S
Group※ Gender	65. 682	2	32.844	1.039	.355	NS
Error	12267.306	388	31.617			
Total	1764168	395				
Corrected Total	16780.699	394				

In summary, the findings of the study can be summarized as follows:

1. The results revealed that students who received instruction using CAI performed significantly better on examinations than those who received instruction using the explanatory method.
2. Compared to students in the control group who received expository instruction in mathematics, students in the experimental group who received CAI instruction had mean retention scores that were significantly higher.

Discussion

The study discussed its findings in relation to three items discussed below:

The impact of computer-assisted instruction (CAI) on students' mathematics performance was investigated. The relevant mean performance scores and standard deviations for the pretest and posttest for the experimental and control groups are shown. The fact that the experimental and

control groups' mean pretest scores did not significantly differ suggests that both groups' baseline levels of behavior and performance were the same. The pretest and posttest mean scores of the experimental and control groups were significantly different, indicating that learning had occurred. This result is consistent with a prior investigation by Kanandiebo (2017) into the impact of CAI on pupils' performance in mathematics. It suggests that including CAI into the teaching of mathematics may enhance student achievement. The researchers concluded that mathematics teachers should think about using CAI into their lesson plans.

The Impact of CAI on students' ability to retain Mathematics knowledge examined. The outcome along with the average and standard deviation of retention scores of student in both treatment and expository groups. The results show discrepancy in mean difference in the treatment and control which suggests that students exposed to CAI have more retention ability than their control counterpart. The findings also agree with those of Kanandiebo (2017) which confirmed the efficacy of CAI in promoting more retention than the control.

The study further indicate that gender has no appreciable impact on pupils' retention and performance in mathematics. The findings of this study are consistent with those of Aguele and Uhumniah's research from 2018, which found that gender, has little bearing on pupils' performance and capacity for information retention in mathematics. These outcomes can be attributed to the effective use of CAI in arithmetic instruction and learning, regardless of gender.The study concluded that CAI has a positive statistical influence on achievement and retention when used successfully in the teaching of mathematics based on its findings.

Conclusion and Recommendations

The study's conclusions confirmed that, when used in mathematics instruction, gender has no statistically significant impact on pupils' performance or retention. The researchers suggested, among other things, that since CAI has been proven to be successful, mathematics teachers incorporate it into their lessons. When using CAI to teach mathematics, math teachers should also be sensitive to gender issues

References

Abakpa,B.O and Amo (2016). Effect of Advanced Organizer on upper Basic Two students' Achievement in Mathematics in Gboko Local Government Area of Benue State, Nigeria. Abacus:The Journal of Mathematical Association of Nigeria,4(1), 227- 235.

Abdul-Ganiyu, A.(2014)Education in mathematics for sustainable development is real. Keynote speech given during the Mathematical Association of Nigeria's 511st annual conference's opening ceremony on September 2, 2014, at the University of Ilrin.

Aguele,I.I.and Agwagah, N.V. (2018). Female participation in Science, Technology and Mathematics (STM) education in Nigeria and national development, Journal of Social Science. 15((2) 121-126.

Aguele,I.I.and Uhumniah. (2018). Journal of Social Science, 15((2), 121-126. Female participation in Science, Technology, and Mathematics (STM) education in Nigeria and national development.

Ajai,J.T.and Imoko, B.I.(215).Gender differences in Mathematics achievement and retention scores: A case of problem based learning method. International Journal of Research in Education and Science. 1(1), 45- 50.

Badmus,G.A,(2012). Changes in contents .and teaching of school Mathematics. A paper presented September, 15th- 17th.at the National Mathematical Education summit. Abuja,

Eze, T.I.; Ezenwafor,J.I,and Onwusa,S.C.(220). Effect of Computer-assisted instruction on students' academic achievement and retention of auto-mechanics technology in technical colleges. The international journal of humanities and social studies. 8(7), 87 - 92

Gambari,A.I, Shittu, A.T.& Taiwo,O.A.(2013). Enhancing students understanding of algebra concepts through cooperative computer instruction. Gazi Journal of Education. 1(1), 29- 43

Iji, C. O.(2005). Effect of basic programming and logo on junior secondary school pupils' proficiency and retention in geometry. 30(1): 67–77 in Journal of the Mathematical Association of Nigeria (MAN)

Isiaka, A,G; Victoria,I.EAnyanwu,R,C.(2014).Comparative effects of two modes of computer-assisted instructional pacages on geometry achievement. Contemporary Educational technology 5(2) 110- 120

Kanandjebo, L.N. (2017). The effects of 'Geometry sketchpad' on grade 12 learners' performance in Geometry.http://hdl.handle.net110702367

Kolawale, E.B.(2007). Effects of cooperative and competitive learning styles on Nigerian students' academic achievement in mathematics. Review of Educational Research, 3, 1, 33–37

Kurumeh. M.S,(2014) Effects of the ethno-mathematics approach on pupils' recall of menstruation and geometry. Abacus, the official publication of the Nigerian Mathematical Association (MAN), 32(1), 103–113.

Onyegegbu, S.O. (2002). Sex, Age and Performance in Mathematics. Unpublished PH.D thesis, University of Nigeria, Nsukka.

Ojo, S.G. (2015). Effects of Animated Computer-Based instructional packages on Achievement and interest of junior secondary school students in Nigeria. Unpublished Ph.D Dissertation University of Nigeria, Nsukka

Western African Examination Council, 2019.SSCE, May/June Examinations, Chief Examiner's Report (Nigeria)