Effects of Computer-Assisted Instruction on Mathematics Achievement among Secondary School Students in Rivers State, Nigeria

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***Abstract*: The study investigated the effects of computer-assisted instruction on mathematics achievement among secondary school students in Rivers State. Two research questions and two hypotheses guided the study. The design was quasi-experimental. The population of the study was 215 students in a senior secondary school Kpor in Gokana. The sample of the study was 35 students. The sample size was drawn using simple random sampling technique. The instrument used to collect data was multiple choice achievement test. The instrument was validated by experts in computer science education and the researchers, while the reliability of the instrument was established at 0.81. Mean and standard deviation was used to analyze pre-test and post-test scores to answer research questions, while z-test was used to test the hypotheses at 0.05 significant level. The findings of the study showed that students taught with computer assisted instruction performed higher than those taught with traditional instructional methods. Findings also revealed that there is a significant difference between the pretest and post-test achievement scores of students taught Mathematics with computer assisted instructional method. The study recommended among others that government should integrate computer and educational software into the mainstream of mathematics curriculum from the junior secondary school level as this will help to prepare students for stellar performance in Mathematics at senior secondary level.**

***Keywords*: Computer-aided instruction, Mathematics Education, Rivers State.**

I. INTRODUCTION

The root of mathematics education is mainly based on the history of mathematics and it has played an important role in the development of the society from prehistoric time to the present day. The history of mathematics is similar to the history of mathematics education; it plays a crucial role in the educational context. It is also essential in everyday life activities, in that mathematics is known as a modeling subject, most educational opportunities and careers require mathematical knowledge. Until 1980s mathematics was viewed as a disembodied set of objective truths to be communicated to the students. Pilli and Aksu (2013) suggest that people perceive mathematics from an absolutist perspective and undoubtedly, this is reflected from the mathematics they studied in school rather than an insight into the discipline, this often led many students entering into the higher level of study for further preparation in mathematics to successfully meet their educational and career goals.

The traditional models for Mathematics education, such as Thorndike's stimulus Response Bond theory, the progressive movements effort to make learning vocationally relevant and schooling more efficient, the curricular changes associated with new mathematics and the emphasis on role facts, skills and procedures of back-to-basics movement was found within the versions of the past century and all developed within the perspective procedural formalist paradigm. Thorndike and his colleagues contended that mathematics is best learned in a drill and practice manner and viewed mathematics as a hierarchy of mental habits or connections that must be carefully sequenced, explicitly taught and be practiced with much repetition for learning to occur (Roschelle et al., 2010).

Many cognitively oriented mathematics researchers were changing on the way the constructivist tried to offer a detailed picture of how learning takes places in context with the drawing of philosophical, anthropological, and social psychological point of views. The publication of the National Council of Teachers of Mathematics (NCTM) standards was accompanied by a growing awareness of an interest in research, examining the significance of culture, especially the interaction of student culture and classroom culture, to the construction of meaningful mathematics understanding. Usman and Igbozuruike (2019) observed that in the 1990s, there was broad recognition that teaching mathematics to all students required something other than the transmission of objective and incorporeal content. In the last thirty years, a noticeable and extensive research in many areas has contributed to major shifts in the fundamental views of how learning occurs as well as developing rich knowledge basis for effective instruction.

Of recent, the mathematics education community is making dramatic changes in the curriculum, instructions, and assessment. These changes include several organizational decisions which have to be made regarding how to segment and sequence the mathematics topics. It also includes how to develop the students' activities and their mathematics thinking abilities. Mathematics education is changing as it seeks new

ways to improve mathematics instruction quality for learners (Pentang, 2021). This shift is occurring simultaneously as mathematics education research is experiencing both new methods and a widespread of implementation of several information technologies advancement.

In today's "information age" the growth of the technology and computer-oriented education system guide educators to explore new teaching methods that can be used at any level of classroom environment as an alternative to teacher-directed techniques (Christensen, 2016). The NCTM technology principle states that mathematics instructional programs should use technology to help students understand mathematics and should prepare them to learn Mathematics, in this increasing technological world. Computer and the internet make possible new methods of delivering instruction so that students will have choices of when, where and how they learn mathematics.

Computer Assisted Instruction (CAI) is a narrower term and most often refers to the use of computers to present drill-and-practice, tutorials or simulative activities offered either by themselves or as supplement to traditional teacher directed instruction (Mangal & Mangal, 2016; Köklü & Topçu, 2012). In this study, CAI refers to the instructions that are carried out by using educational mathematics software to facilitate learning and teaching through the direct interaction between students and the computer individually. Tabuena and Pentang (2021) stated that interactive features the software provides such experience where Mathematics concepts are presented in virtually concrete forms, whereby activities are interesting and challenging. The use of computer as a teaching/learning tool, also suggest opportunities for learner's control, improved enthusiasm, associations to the real world and enhance students' achievement as a measure in variety of ways, including, standardized achievement test (Christensen, 2016). Köklü and Topçu (2012) added that CAI could also benefits students by improving their self-sufficiency and independency in learning.

The traditional Instruction (TI) approach on the other hand refers to the use of conventional standard methods and tools in teaching mathematics in the classroom, such as the use of rulers, pencil and paper to carry out the content of the given subject (Spiezia, 2010). Learning takes place in this standard method in the classroom as well, work is presented on the board and the use of textbook is commonly practiced. The instruction is teachers' oriented, question-answer method is mostly used. However, Biagi and Loi (2013) have observed that CAI benefits most students more when compared with traditional instruction, arguing that CAI increases the students' interest, reduces anxiety, provides more time on task, and provides instant feedback. Good understanding of developmental mathematics is essential for further studies in mathematics as well as better understanding of other science subjects. The traditional method of teaching mathematics has always dominated teaching and learning of developmental mathematics in secondary schools. Though many researchers agree that CAI is innovative, engaging and helps students to learn at a higher pace (Ragasa, 2008), however, some scholars have found out that students taught with conventional method and CAI acquire the same knowledge and skills (Ramani & Patadia, 2012), only that students taught with the latter approach tend to display enhanced positive attitude towards further learning of mathematics (Cotton, 2001). In this light, this study investigated whether there are differences in the academic achievement of students enrolled in a developmental mathematics course using traditional instruction and the computer-assisted instruction.

Statement of the Problem

The use of computer technology to supplement traditional mathematics instruction and to deliver instruction online to secondary school students or developmental mathematics students is a recent development. Mathematics education is changing as it seeks new ways to improve mathematics instruction quality for learners. This shift is occurring simultaneously as mathematics education research is experiencing both new methods and a widespread of implementation of several information technology advancements. Although, considerable research indicates that computer-assisted instruction can have a positive impact on learning for students of all ages and in variety of content areas, however research is not limited and inconclusive for only secondary school students or students in developmental mathematics, considering the level of poor assimilation and method of teaching that are associated with the traditional teaching in mathematics. Some researchers think that computer assisted instructions has great potential for improving developmental education, and the use of technology as a best practice for teaching mathematics. Similarly, the use of technology in Mathematics was recommended as a best practice for all students.

Technology is essential in teaching and learning Mathematics as it influences the subject that is being taught and enhances student's learning. However, the extent to which computer assisted instruction and traditional teaching methods improve students' performance in mathematics, with respect of students in Rivers State. Based on the above, this study sought to examine the extent to which a technology-based intervention can offer effective instructions for Mathematics students in secondary schools and developmental mathematics students at all levels. This study is significant to the principals and other educational stakeholders as findings will encourage principals to implement the use of computer software so as to create an environment that will enhance the achievement of greater results in the student's educational productivity, and thus enlighten them on the effective use of these technological facilities improve students' achievement.

Research Questions

The following research questions guided the study.

1. What is the effect of traditional instructional method on the Mathematics achievement of students as measured by their pretest and post-test scores?
2. What is the effect of computer-assisted instructional materials on the mathematics achievement of students as measured by their pretest and post-test scores?
3. What is the mean difference of the post-test achievement scores of students taught mathematics using traditional and computer-assisted instructional methods?

Hypotheses

The following null hypotheses were tested at 0.05 alpha level of significance.

1. There is no significant difference between the pretest and post-test achievement scores of students taught Mathematics with traditional method.
2. There is no significant difference between the pretest and post-test achievement scores of students taught Mathematics with computer assisted instructional method.
3. There is no significant difference between the post-test achievement scores of students taught mathematics using traditional and computer-assisted instructional methods

II. METHODOLOGY

The design of the study was quasi-experimental Quasi experimental design demonstrates the causality between an interposition and an outcome. Intact classes were used to avoid disrupting the academic programmes in the selected schools at the time of the study. The population of the study was all the students in Senior Secondary School Kpor in Gokana local government Area Rivers State. The permission to conduct the study in the said school was sought and obtained from the principal. The researchers explained the reasons for this research to the Mathematics teachers and all the 215 target students, and thus requested their corporation and participation. All the two Mathematics teachers and 215 students, comprising 125 SS1 and 90 SS2 students formed the population of the study. The sample of the study was 35 students which is about 16% of the population. The sample size was drawn using simple random sampling technique. The instrument used for data collection was a 20-item multiple choice achievement test, covering six topics in mathematics. The instrument was validated by experts in computer science education and the researchers, while the reliability index of the instrument 0.81 coefficient using K. Richardson formula (KR -20). The instrument was administered to students in the control group (in which the teacher did not use computerized materials, though instruction was teacher oriented). The instrument was also administered to students in the experimental group (treatment group in which the teacher used computerized materials). The data collected was used for both the pre-test and post-test. The pre-test score and post-test scores were weighted to determine the mean gain to answer research questions, while z-test was used to test the hypotheses at 0.05 significant level.

III. RESULTS

Table 1: Traditional instructional method on mathematics achievement of students' test

Traditional Instruction		Mean	N	Std. Deviation	Mean gain
Mathematics achievement	Pretest	7.4000		1.14248	
	posttest	8.9000	20	.71818	1.50

Table 1 revealed that pretest and post-test mean scores of the students taught with traditional instructional materials are 7.40 and 8.90. It was revealed that students' achievement in mathematics was improved from 7.40 to 8.90. The improvement was shown by the mean gain value of 1.50 (8.90-7.40).

Table 2: T-test analysis of students' achievement on mathematics test for traditional instruction

Traditional Instruction	N	Mean	Std. Deviation	Df	z-cal.	z-crit.	Decision
Pretest	20	7.4000	1.14248	18	6.38	±1.96	Statistically significant Ho_2 rejected)
Post test		8.9000	.71818				

Table 2 revealed that students taught with traditional instruction method have pretest mean and standard deviation scores of 7.40 and 1.14, without treatment, their post-test mean and standard deviation scores are 8.90 and 0.72 respectively. With degree of freedom of 18, the calculated z-value of 6.38 is greater than the critical z-value of ±1.96 therefore, the null hypothesis was rejected. By implication, there is a significant effect of traditional instructional method on the Mathematics achievement of students as measured by their pretest and post-test scores.

Table 3: Mean and standard deviation of computer assisted instructional materials on the mathematics achievement based on their pretest and post-test scores

		Mean	N	Std. Deviation	Mean gain
Mathematics Achievement	Pretest score	7.3333	15	1.63299	9.80
	Posttest	17.1333		1.30201	

Table 3 revealed that pretest and post-test mean scores of the students taught with computer assisted instructional materials are 7.33 and 17.13. It was revealed that students' achievement in mathematics was improved from 7.33 to 17.13 respectively. The improvement was shown by the mean gain value of 9.80 (17.13-7.33).

Table 4: T-test analysis of students' achievement on mathematics test for computer assisted

Computer Assisted Instructional	N	Mean	Std. Deviation	Df	Z-cal.	Z-crit.	Decision
Pretest	15	7.3333	1.63299	13	18.58	±1.96	Statistically significant (Ho_1 rejected)
Post test		17.1333	1.30201				

Table 4 revealed that students taught with computer assisted instruction have pretest mean and standard deviation scores of 7.33 and 1.63, after treatment, they have mean and standard deviation scores of 17.13 and 1.30 respectively. With degree of freedom of 13, the calculated z-value of 18.58 is greater than the critical z-value of ±1.96 therefore, the null hypothesis was rejected. By implication, there is a significant difference between the pretest and post-test achievement scores of students taught Mathematics with computer assisted instructional method.

Table 5: Traditional Instruction and computer assisted instructional methods on the mathematics students' achievement test

Variables	n	Mean	Std. Deviation	Mean difference
Computer-Assisted Instruction	15	17.1333	1.30201	8.23
Traditional Instruction	20	8.9000	.71818	

Table 5 revealed post-test mean scores of students taught Mathematics with computer-assisted instructional strategy and traditional instructional strategy is 17.13 and 8.90 respectively. These scores reveal that students taught with computer-assisted instructional method had higher achievement than their counterparts taught with traditional instructional method. The mean difference of 8.23 (17.13 - 8.90) show that computer-assisted instructional method is more effective than and superior to traditional instructional strategy.

Table 6: T-test on the mean difference of post test scores on Mathematics students taught with guided-discovery and traditional instructional strategies as measured by their post-test performance.

Variables	n	Mean	Std. Deviation	df	t-cal.	t-crit.	Decision
Computer-Assisted Instruction	15	17.1333	1.30201	33	23.72	1.96	Significant (Ho_5 rejected)
Traditional Instruction	20	8.9000	.71818				

Table 6 revealed that students taught with computer-assisted instructional strategy obtained mean and standard deviation scores of 17.13 and 1.30, while their counterpart taught with traditional instructional strategy obtained mean and standard deviation scores of 8.90 and 0.72 respectively. With degree of freedom of 33, the t-calculated value of 23.72 is greater than the t-critical value of 1.96; therefore the null hypothesis was rejected. By implication, the achievement score of students taught Mathematics with computer-assisted instructional strategy significantly differed from achievement score of students taught with traditional instructional strategy.

IV. DISCUSSION

Traditional instructional method on mathematics achievement of students' test

From table 1, the findings of the study revealed that the mean pre-test and post-test scores were 7.40 and 8.90 respectively, while the mean gain value was 1.50. The gain revealed that students' achievement in mathematics lesson was improved, though, relating its mean gain value with the gain value of the computer-assisted instructional material approach, CAI, foster effective academic performance among the learners. The finding is not surprising, in that the traditional (conventional) method of teaching is predominantly teacher-centered; it encourages the learner to be a passive listener, inactive and a boring learning process. Unlike the computer assisted instructional approach where the learners are enhanced to construct their own understanding according to the constructivism theory (Hakverdi-Can & Sonmez, 2012), the traditional (conventional) approach does not encourage the learner to construct their own understanding of the given learning concept, in that they are just passive learners due to the teacher-centered approach used. As a result, due to this poor quality delivery approach, the students struggle to assimilate the learning concepts which thereby lead to absent mindedness of the learner while presently in the class.

This finding agrees with Shapley et al. (2011) where student-centered learning is an instructional approach that encourages students' active engagement in the learning process as opposed passively receiving information in the traditional teacher-centered approach. No doubt, in the traditional teacher-centered approach, the students are not encouraged to address their own learning needs and interest, while the instructor facilitates their learning with varying amount of guidance (Ukaigwe & Igbozuruike, 2020). From table 2, the finding of the hypothesis is that there is no significant difference in the academic achievement of the students that are taught using the traditional instructional method as revealed by their pre-test and post-test scores. Though this study reports that difference exist in students' pretest and post test scores, however the difference is statistically insignificant. The reason for similar scores by students could not be established in this study, however, the reason for such a close similarity in students' scores may be related to poor lessen preparation on the part of the teacher, lack of good instructional materials, change in mode of instruction and so on. However, the result is contrary with Schoppek and Tulis (2010), who reported in their study that a significant difference existed in the performance of students instructed with computer-assisted instructional approach conventional approach, adding that students taught using the conventional approach performed higher in achievement test.

Computer assisted instructional method on the mathematics students' achievement test

From table 3, the findings of the study showed that the mean pre-test score of computer assisted instructional materials Mathematics achievement test was 7.33, whereas the post-test score was 17.13. The mean gain value was 9.80, and thus implied that computer assisted instructional method improved students' achievement. These findings indicate that the instructional components of the CAI software were very effective in helping the participants improve their Mathematics achievements. The computer assisted instructional materials enhanced the students' learning abilities in Mathematics.

This finding is in line with Bai et al. (2012), who asserted that one would assume the mastery experiences in the study which suggest that their self-efficacy is improved and ultimately impacted their academic performance. The findings also agree with the National Council of Teachers of Mathematics Standard [NCTM], whose study encouraged teachers to frequently use student-centered approach to emphasize mathematical thinking, reasoning, and engaging in an interactive environment (Alhassan, 2012). This result further supports Afolabi and Kinbobola (2009), who reported a significant difference in the performance of students taught using CAI. However, the result opposes Spradlin and Ackerman (2010), who discovered that those taught using conventional method performed better than those exposed to CAI. The result shows that the treatment given to the experimental group had a positive effect on them as it shown by the higher mean score.

Computer-assisted instruction provides differentiated Mathematics education for both teachers and students (Ash, 2005). Some forms of the CAI offer extensive opportunities for recitation of Mathematical concept. One of the effective ways of teaching Mathematics is active participation. This is in agreement with Pramila et al. (2012), who reviewed empirical articles and concluded that computer-based materials as prepared within the constructivism pedagogical paradigm enhances students' achievement. Hence students are not just passive learners, they do not watch the teachers' demonstration of how to solve Mathematical problems, but they understand the mathematical concepts by doing the Mathematics. The learner should be part of concrete activities and real-life scenarios.

This finding is not surprising as the CAI encourages student-centered instructional approach whereby the students are active and conceptually involved in the learning process. This enables them to be involved in what is taught, construct their own knowledge, apply, and tackle other tasks that require high cognitive skills. From table 4, the finding of the hypothesis is that there is significant difference in the mean score and gains in the pre-test and post- test in the result of the students taught with computer-assisted instructional materials. This implies that the use of computer actually caused the students achievement to improve considerably. This finding corroborates the findings of Bitter and Pierson (1999), which suggests that due to the numerous uses of the package, computer assisted instruction focuses on the effective approach delivery. This might be responsible for the significant difference in the pre-test and post-test scores. The result also shows that the treatment given to the experimental group had positive effect on them as it is shown by the higher mean score. This might be due to change in mode of instruction that is from teacher-centered (i.e. conventional method) to students-centered (i.e. computer-assisted instruction).

Computer assisted instructional Method and Traditional Instructional Method on Students' Performance in Mathematics

This study found out those post-test mean scores of students taught Mathematics with computer-assisted instructional strategy and traditional instructional strategy were 17.13 and 8.90 respectively. These scores revealed that students taught with computer assisted instructional strategy had higher performance than their counterparts taught with traditional instructional strategy. The mean gain of 8.23 (17.13 - 8.90) shows that computer assisted instructional strategy is more effective than and superior to traditional instructional strategy. The reasons for this finding may be related to the constructivist ideologies that postulate that students learn more effectively when they are exposed to learning environment that involves hands-on tools such as computer and application to manipulate concepts, ideas and objects to discover new and concrete knowledge. This finding is in accord with Ramani and Patadia (2012), who found out that pupils taught with computer assisted methods scored higher in performance test than their counterpart instructed with the conventional approach. The scholars attributed their findings to the idea that students tend to retain knowledge more effectively when they were taught with computer-assisted method, than the traditional method.

This study discovered that significant difference existed between the mean scores of Mathematics students taught with computer-assisted and traditional instructional strategies. This study is in line with Ragasa (2008), who reported that a significant difference existed between the mean performance of student instructed with computer-assisted method and those exposed to lecture method, with the result that students taught with discovery method score significantly higher than their counterpart instructed with lecture method. These findings are consistent with the assertions of Spiezia (2010), who observed that learning via computer-assisted strategy helps learners to develop intellectual abilities, thought processing abilities, coherence skills and reflective thinking necessary for advanced cognitive development for success in life. In the light of this finding, it is necessary for teachers to assist learners with learning materials with which to engage students in computer-assisted learning activities.

V. CONCLUSION

This study investigated the effects of computer-assisted instruction on mathematics achievement, based on the findings; this study concluded that the use of computer-assisted instructional method has higher positive effects on students' performance in mathematics than the traditional instructional method. Given this outcome, secondary school managers are encouraged to plan towards and integrate CAI into the mainstream of instructional system regarding mathematics to bolster students' academic achievement in the subject.

VI. RECOMMENDATIONS

1. Government should integrate computer and educational software into the mainstream of mathematics curriculum from the junior secondary school level as this will help to prepare students for stellar performance in Mathematics at senior secondary level.
2. School managers should regularly provide training for mathematics teacher to improve their teaching skills in using both computer-assisted method and traditional teaching method as this will boost teachers' performance and students' achievements.
3. The New National Mathematics Curriculum and Ministry of Education should work together in ensuring that mathematics textbooks are revised and structured in line with novelties in educational and computer technologies regarding teaching and learning of mathematics.

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