ENHANCING PUPILS' UNDERSTANDING OF GEOMETRIC CONCEPTS THROUGH COLLABORATIVE COMPUTER INSTRUCTION

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Abstract
The study investigated enhancing students understanding of geometry through collaborative computer instruction. The researchers adopted quasi experimental approach using the pre test-post test non equivalent control group design. Three research questions and three hypotheses guided the study. The population of the study comprised all primary six (6) pupils in all the private schools in Owerri Municipal Council of Imo state. A sample size of sixty (60) pupils participated in the study. The instrument used for data collection was researchers made Mathematics achievement test (MAT) and were validated by two experts, from mathematics education and measurement and evaluation. The reliability of the instrument was determined using kuder-richardson method (K21) and it found to be 0.83. The data generated was analyzed using mean, standard deviation, t-test and ANOVA to test the hypotheses at 0.05 level of significant. The results of the study showed that computer instruction enhances primary school pupil's achievement in geometry and that the enhancement did not significantly depend on gender. Based on the findings it was recommended that primary school teachers should be trained on the effective use of computer for individualized and collaborative instruction through seminars, workshop and conferences.
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KEYWORDS: Collaborative learning individualized Instruction, Computer Instruction, and geometry.

Introduction

The knowledge of mathematics plays a significant role in enhancing the country's social and economic development. Mathematics occupies a central place in the Nigerian educational system. Ojo (2002) pointed out that mathematics is the gate and key to science. The importance of mathematics to nation building has led the Federal Government of Nigeria to make mathematics a core subject to be offered by students at all levels of education in Nigeria (FRN, 2004). Okafor (2002) noted that mathematics is a compulsory subject for entry requirement into university education. Pass at credit level in mathematics is expected to qualify an individual for further study. In spite of its importance, Mathematics is a subject that is considered difficult and boring by many students. For instance, weaker students feel anxiety toward mathematics, and this anxiety affects their performance in the subject (Van Wyk, 2012). According to Woodard (2004), students who lack mastery in mathematics are less successful in mathematics examination. Furthermore, students' performance in mathematics was found below average in the Senior Secondary School Certificate Examination (SSSCE) in Nigeria. West African Examination Council (WAEC) revealed that less than 30% passed at credit level from 2004 to 2012. The West African Examination Council (WAEC), Chief Examiners' report (2012) confirmed that candidates had weak presentations on questions similar to triangle; this had some adverse effects on their performance. Also, the WAEC Chief Examiners (2007) report revealed that candidates lack interpretation and handling of trigonometric construction and its application to angles and triangles, this shows that the candidates did not show any firm grasp of detail needed to answer the questions. These problems emanate as a result of a lot of problems facing the effective teaching and learning of mathematics at all levels of Nigerian educational institution (Bankole, 2006). Okafor (2002) and Okeke (2006) identify poor teaching methods as the major factor contributing to the poor performance of students in mathematics.

The instructional method employed by the teacher plays an important role in the acquisition of skills and meaningful learning. It is one of the factors that make students become passive and have less interaction with each other in doing tasks. Zakaria, Chin and Daud (2010) concluded that positive changes take place when a teacher changes his teaching method towards a more students-centered approach. Lecture method contribute to more than 85% of the instruction in schools in which students are isolated from one another and forbidden to interact (Johnson, Johnson, Holubec, & Roy, 1984). Sule (2003) reported that the teaching of mathematics without the instructional media contributes a lot to the failure in the mathematics.

Geometry is an important part of mathematics curriculum. Geometry thinking includes a strong focus on the development of careful reasoning and proof,
using definitions and established facts (NCTM, 2000). Geometry helps students gain basic skills such as analysis, comparison and generalization and is useful in representing and solving problems in other areas of mathematics and in real-world situations. However, many students develop misconceptions and other fail to go beyond simple visualization of geometric figures (Mistretta, 2000).

Therefore, to enhance the understanding of geometry, students must be more active in the classroom and must creatively acquire knowledge, especially in understanding and solving mathematical problems. Students should be given the opportunities to develop, to interact, and to share with friends through collaborative learning activity. Thus, the cognitive and affective development of students in mathematics can be improved. An alternative method for the delivery of material is collaborative learning (Zakaria, Solfitri, Daud & Abidin, 2013).

Collaborative learning is a strategy in which students learn in small groups in which they interact within their group and learn from each other's experiences. Johnson (2002) highlights the advantages of collaborative learning and in his view, by working together, the members of small groups are able to overcome obstacles, act independently and responsibly, rely on the talent of team members, trust others, speak up, and make decisions.

Arends (2000) views that it is important to provide learning takes that student have value for and have a high chance of completing that successfully. Totten, Sills, engage in discussion, take responsibility for their own learning, and thus become critical thinkers. Schmuck and Schmuck (1997) illustrate advantages of students groups under following headings:

a. Facilitating group inclusion and psychological membership: students seek a niche for themselves in the peer group.

b. Establishing rules and routines: Group members are very concerned about what is expected of them.

c. Establishing shared influence and collaboration: One group tests the authority of the teacher; the other group establishes the peer pecking order.

d. Pursuing individual and academic goals: The classroom enters a stage of development for working productively on academic goals.

The potential benefits of Computer Assisted Instruction (CAI) cannot be underestimated in the contemporary world. There is a plethora of established findings on the instructional value of computer, particularly in advanced countries. There are now several CAI packages on different subjects. It is obvious that the current trend in research all over the world is the use of computer facilities and resources to enhance students' learning (Yusuf & Afolabi, 2010). Therefore, the position of mathematics makes it necessary for the use of innovative pedagogical strategy that will enable teachers meet the challenges of teaching and learning of the subject especially in this era of information age. Several researches have shown that using Computer-Assisted Instruction (CAI) has a positive effect on students' achievement compared to traditional methods. For instance, Anyamele, Nwokolo, Anyachebelu, and Anemelu (2012) found that students taught mathematics using
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CAI package performed better than those taught using the conventional method of instruction. Bayturan and Keşan (2012) reported that teaching mathematics with a computer assisted instruction method increased student success significantly in mathematics lesson. Pilli and Aksu (2013) found that students taught mathematics at the primary school level in North Cyprus performed better than those taught using conventional method. Similarly, college students taught statistics using lecture-plus-CAI obtained higher averages on midterm and final exams than students taught using lecture method only (Basturk, 2005). Students taught using traditional instruction combined with the use of computer performed significantly better than students taught using traditional instruction in a college setting (Akour, 2006). Yusuf, Gambari and Olumorin (2012). Yusuf and Afolabi (2010), Fajola (2000) and Dalton, Hannafin and Hooper (1989) reported from their various researches that students who worked collaboratively using computer-assisted instruction significantly outperformed those who worked individually using CAI.

Gender bias in Nigeria and Africa as a whole is still very prevalent (Arigbabu & Mji, 2004). However, some researchers still found that there are still significant differences in the cognitive, affective and psychomotor skill achievements of students in respect of gender (Aguele and Uhumniah (2008); Croxford (2002); Kolawole, (2007); Viann (2004) found no significant gender related differences, but female achieved slightly higher grades than male students. However, Kolawole (2007) found that boys performed better than girls in both competitive and cooperative learning strategies when he conducted a research on the effects of competitive and cooperative learning strategies on Nigerian students’ academic performance in mathematics. Contrarily, Aguele & Uhumniah (2008) and Croxford (2002), found in their studies at various times, that male students achieved significantly better than female students in science education. Garduno (2001) found no statistically significant differences in achievement or self-efficacy in seventh and eighth-grade students in mathematics in single-or-mixed-gender groups. Fajola (2000). Gambari (2010) and Yusuf and Afolabi (2010) reported that gender had no effect on academic performance of students in computer-assisted cooperative learning. These contradictory findings have caused for inclusion of gender as one of the moderating variable or this study. Evidences from studies in Nigeria indicated that very little research efforts had been directed at collaborative learning. This approach has been highly recommended for teaching at all levels, as stated by the Federal Government of Nigeria (2004) in the National Policy on Education. If the CCI and ICI methods of teaching are used to teach mathematics concepts, what would be their effects on students’ academic achievement in mathematics? In view of this, the effects of CCI and ICI on Nigerian primary school pupil’s academic achievement in mathematics were investigated in this study.

Purpose of the study

The purpose of this study was to determine whether collaborative computer-assisted instruction (CCI) would enhance understanding of geometry
concepts. Specifically, the study examined:
(i) The mean achievement scores of pupils taught geometry using collaborative Computer-Assisted Instruction (CCI), Individualized Computer Instruction (ICI) and Conventional Teaching Method (CTM).
(ii) The difference between the mean achievement scores of male and female pupils taught geometry using CCI.
(iii) The difference between the mean achievement scores of male and female students taught geometry using ICI.

Research questions
The following research questions guide the study:
(i) What are the mean achievement scores of pupils taught using geometry using CCI, ICI and CTM?
(ii) Is there any difference between the mean achievement scores of male and female students taught geometry using CCI?
(iii) Is there any difference between the mean achievement scores of male and female pupils taught geometry using ICI?

Research hypotheses
The following hypotheses were tested at 0.05 level of significance
(i) There are no significant difference between the mean achievement scores of pupils taught geometry using CCI, ICI and CTM.
(ii) There is no significant difference between the mean achievement scores of male and female pupils taught geometry using CCI.
(iii) There is no significant difference between the mean achievement scores of male and female pupils taught geometry using ICI.

Methodology
The research design adopted for the study is a pretest-posttest intact group design. Three levels of independent primary variable (two treatments and a control), two levels of gender (male and female) were investigated on students' performance in geometry. The design layout is as shown in Table 1.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Pretest</th>
<th>Treatment</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Group</td>
<td>$O_1$</td>
<td>CCI</td>
<td>$O_2$</td>
</tr>
<tr>
<td>Experimental Group</td>
<td>$O_2$</td>
<td>ICI</td>
<td>$O_3$</td>
</tr>
<tr>
<td>Control</td>
<td>$O_3$</td>
<td>CTM</td>
<td>$O_{n}$</td>
</tr>
</tbody>
</table>

Multi-stage sampling techniques were adopted. Firstly, purposive sampling procedure was adopted to obtain three Private Primary Schools out of twenty-four in Owerri Municipal Council Area, Imo State Nigeria. These schools were sampled based on facilities (computer laboratories, and manpower). The three Primary schools were randomly assigned to experimental group I (CCI group).
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experimental group II (ICI) and control group (traditional teaching methods)
respectively. Using stratified sampling technique was used to select sixty (60)
pupils. The experimental group I had 20 (10 male – 10 female), experimental group
II had 20 (10 male – 10 female) students and control 20 (10 male – 10 female)
pupils.

Mathematics Achievement Test (MAT) in geometry was used as a test
instrument, while Computer-Assisted Instructional Package (CAIP) was used as a
treatment instrument. The MAT consists of 25 multiple choice objective items with
four options (A–D). MAT was validated by experts in Mathematics, and test and
measurement experts and test retest approach were used for the reliability, it found
to be 0.80 using kuder-Richardson Formula 20.

Treatment instrument (CAIP) was developed by researchers and
programmer. CAIP was used for collaborative learning and individualized
instruction respectively. The CAIP consists of four topics in mathematics in
primary School curriculum. These concepts were identified as one of the difficult
concepts that students find difficult to understand. The necessity for researcher-
made computer package was based on the fact that the commercially produced
computer-assisted instructional packages are not common in Nigeria. Even the
available foreign CAI packages were not relevant to the topics or objectives to be
achieved in this study. As a result of this, developing a computer package for use by
the researcher was inevitable. The objectives and the modalities of the experiments
were specified and operational guide was produced before the commencement of
the treatment. The Computer Assisted Instructional Package (CAIP) with the
mathematics content was installed in the system. The computer presents
information and displays animation to the learner on each of the units after which
the students assessed themselves with objective questions at the end of each unit.
The students could only proceed to the next unit, if they satisfactorily answered the
questions. When a student fails a question after three attempts, the computer will
log-out the pupils until the instructor log-in again. The students must have 100%
mastery of the content before proceeding to the next unit.

The researchers administered the Mathematics Achievement Test (MAT)
on sample pupils as pre-test to ascertain the equivalence of the students before the
treatment. During the four weeks treatment, the CCI and ICI groups were exposed
to the use of collaborative computer instruction and individualized computer
instruction as treatments, while students in control group were exposed to
conventional teaching method. Each of the lesson lasted for forty minutes duration
(200 minutes per week) with five lessons per week. The following are the specific
procedures for each group:

(i) The Cooperative Computer Instruction using Students Team
Achievement Division (STAD) Cooperative Learning Strategy: students
were taught the mathematics concepts using CAIP only. In this strategy,
students were assigned into three member heterogeneous group. Each
member was assigned with different responsibilities (e.g. group leader, time-keeper, scribe/quiet captain). The groups were exposed to CAIP where members complete the reading of the materials and perform the tasks together. To ascertain that there was no free rider, students were given individual task which was marked and recorded against group scores. After the completion of a lesson, students take quiz as a team and reach consensus with respect to the correct answers after which one answer sheet were submitted by the team for which all teammates receive the same 'team score'. The scoring was done based on individual quiz score and team quiz score which were counted equally towards the student's final course grade. High scoring teams is recognized and rewarded in the class. Group processing form was completed after each lesson to determine the group behaviour and correct any irregularity within the teammates.

(ii) **Individualized Computer Instruction Method:** In this method, students were taught the mathematics concepts using CAIP only. The computer presented the instruction on human-to-computer basis. Students proceeded with the geometry contents and study at their own rate without any assistance from their colleagues. Students answered the MAT at pre-test and post-test individually.

(iii) **Control Group: Conventional Teaching Method:** The control group were exposed to lecture method. The researcher taught students in control group using some instructional materials to explain the concept of geometry. Students answered the MAT at pre-test and post-test after four weeks of the teaching.

Immediately after four weeks of treatment, MAT was administered as posttest to measure the achievement of different groups. The mean scores obtained were subjected to data analysis based on the stated hypotheses using One-way Analysis of Variance and Scheffe’s post-hoc analysis was employed to analyze data. The significance of the various statistical analyses was ascertained at 0.05 alpha levels.

**Results**

To test for the hypotheses, the data were analyzed using Analysis of Variance (ANOVA) and Scheffe’s test using Statistical Package for Social Sciences (SPSS) version 11 at 0.05 alpha level. The results are presented based on the research hypotheses.

**Table 1: ANOVA pre-test on CCI, ICI and control groups**

<table>
<thead>
<tr>
<th>Source of Variables</th>
<th>Sums of Square</th>
<th>df</th>
<th>Mean ( )</th>
<th>F-calculated</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>7.900</td>
<td>2</td>
<td>3.950</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within Groups</td>
<td>232.950</td>
<td>57</td>
<td>4.087</td>
<td>0.967ns</td>
<td>0.387</td>
</tr>
<tr>
<td>Total</td>
<td>240.850</td>
<td>59</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ns: Not Significant at 0.05 level
Table 1 shows the result of ANOVA comparison of the two experimental groups and control group. From the table, the calculated F-calculated (0.967, p = 0.387) was not significant at 0.05 alpha level. This implies that there was no significant difference among the mean scores of the experimental group I; experimental group II and the control group at 0.05 level of significance. This results shows that pupils in the experimental groups and control group have the same entry level with regards to previous knowledge of the topic treated. Thus, they are compatible groups.

**Hypothesis One:** There are no significant differences in the achievement of primary school pupils taught mathematics using Collaborative Computer Instruction (CCI), Individualized Computer Instruction (ICI) and conventional teaching method.

To determine whether there were significant differences in the post-test mean scores of the CCI, ICI and control groups, data were analyzed using the analysis of variance (ANOVA).

**Table 2: ANOVA post-test on CCI, ICI and control groups**

<table>
<thead>
<tr>
<th>Source of Variables</th>
<th>Sums of Square</th>
<th>df</th>
<th>Mean ( )</th>
<th>F-calculated</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>17823.333</td>
<td>2</td>
<td>8911.667</td>
<td>33.049*</td>
<td>0.000</td>
</tr>
<tr>
<td>Within Groups</td>
<td>15370.000</td>
<td>57</td>
<td>269.649</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>33193.333</td>
<td>59</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Significant at 0.05 level

Table 2 present the result of ANOVA comparison of the two experimental groups and control group. From the table, the calculated F-calculated (33.049, p = 0.000) was significant at 0.05 alpha levels. This indicates that statistically significant difference was established among the experimental groups and control group. Hence the null hypothesis one (H01) was rejected.

Based on the established significant difference in the post-test achievement scores of the groups, Scheffe’s test was used for post-hoc analysis.

**Table 3: Scheffe’s post-hoc analyses of the groups mean scores**

<table>
<thead>
<tr>
<th>Groups</th>
<th>Mean Scores</th>
<th>Group I (CCI)</th>
<th>Group II (ICI)</th>
<th>Group III (Control)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I (CCI)</td>
<td>84.50</td>
<td>0.574</td>
<td>*0.000</td>
<td></td>
</tr>
<tr>
<td>Group II (ICI)</td>
<td>79.00</td>
<td></td>
<td></td>
<td>*0.000</td>
</tr>
<tr>
<td>Group III (Control)</td>
<td>-45.50</td>
<td></td>
<td></td>
<td>*0.000</td>
</tr>
</tbody>
</table>

* The mean difference is significant at the 0.05 level.

The result in Table 3 indicates that there was no significant difference in the posttest mean scores of students exposed to ICI (X = 84.50) and those exposed to CCI (X = 79.00). It indicates significant difference in the posttest mean scores of students exposed to ICI (X = 79.00) and those exposed to conventional lecture
method (45.50). Significant difference was also established in the posttest mean scores of pupils exposed to CCI (X = 84.50) and those exposed to conventional lecture method (X = 45.50).

**Hypothesis two:** There is no significant difference in the mean achievement scores of male and female students exposed to collaborative computer instruction.

To test this hypothesis, t-test statistic was also used to analyze the mean scores. The summary of this analysis is shown in Table 4.

**Table 4: t-test analysis on achievement scores of male and female students exposed to CCI**

<table>
<thead>
<tr>
<th>Variables</th>
<th>N</th>
<th>df</th>
<th>Mean ( )</th>
<th>SD</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>10</td>
<td>18</td>
<td>84.00</td>
<td>8.111</td>
<td>0.113&lt;sup&gt;ns&lt;/sup&gt;</td>
<td>0.912</td>
</tr>
<tr>
<td>Female</td>
<td>10</td>
<td></td>
<td>85.00</td>
<td>8.445</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ns: Not Significant at 0.05 level

Table 4 presents the t-test of male and female students of experimental group I (CCI). The mean scores of the male pupils were (84.00) and female (85.00) for female. The calculated t-value of 0.113 was not significant at the 0.05 level. This indicates that there is statistically no significant difference between the male and female pupils taught with CCI, (t=0.113, df = 18, p = 0.912). Hence, Ho2 was not rejected. Therefore, there is no significant difference between male and female pupils taught geometry with collaborative computer instructional package.

**Hypothesis three:** There is no significant difference in the mean scores of male and female pupils exposed to individualized computer instruction.

To test this hypothesis, t-test statistic was also used to analyze the mean scores.

**Table 5: T-test analysis on achievement scores of male and female pupils exposed to ICI**

<table>
<thead>
<tr>
<th>Variables</th>
<th>N</th>
<th>df</th>
<th>Mean ( )</th>
<th>SD</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>10</td>
<td>18</td>
<td>78.00</td>
<td>17.512</td>
<td>0.259</td>
<td>0.798&lt;sup&gt;ns&lt;/sup&gt;</td>
</tr>
<tr>
<td>Female</td>
<td>10</td>
<td></td>
<td>80.00</td>
<td>16.997</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ns: Not Significant at 0.05 level

Table 5 presents the t-test of male and female students of experimental group II (ICI). The mean scores of the male students were (78.00) and (80.00) for the female students. The calculated t-value of 0.259 was not significant at the 0.05 level. This indicates that there is statistically no significant difference between the male and female students taught with ICI, (t=0.259, df = 18, p = 0.798). Hence, Ho3 was upheld. Therefore, there is no significant difference between male and female pupils taught with individualized computer instructional package.
DISCUSSION OF FINDINGS

The results of the analysis of ANOVA on the achievement of pupils taught geometry using CCI, ICI and those taught using conventional method of instruction indicate a significant difference in favor of the pupils taught with CCI and ICI. The pupils exposed to CCI and ICI performed better than those exposed to conventional method of instruction respectively. The findings agree with Yusuf, Gambari and Olumorin (2012), Yusuf and Afolabi (2010), Fajola (2000) and Dalton, Hannafin and Hooper (1989) that students taught with collaborative computer-assisted Instruction in physics, biology, and mathematics respectively performed better than those taught with individualized computer-assisted instruction. The result also indicates that those taught with CAI in individualized instruction outperformed those taught using conventional teaching method. The finding agree with the findings of (Basturk, 2005), (Akour, 2006), Anyamene, Nwokolo, Anyachebelu, and Anemelu (2012), Bayturan and Keşan (2012). Pilli & Aksu (2013) found that students taught mathematics using CAI package performed better than those taught using the conventional method of instruction.

The Influence of Gender on the Academic Performance of pupils

The results of analysis of t-test on the achievement of male and female taught using CCI and ICI indicate no significant difference. The finding agrees with the findings of Viann (2004) reported that females achieved slightly higher grades than males. Contrarily, Kolawole (2007) found boys performed better than girls in both cooperative and competitive learning strategies in mathematics. Similarly, Aguele and Uhummiah (2008) and Croxford (2002) found that male students achieved significantly better than female students in science education. Furthermore, this study agrees with the findings of Fajola (2000), Gambari (2010), Garduno (2001) and Yusuf and Afolabi (2010). Yusuf, Gambari and Olumorin (2012) reported that gender had no effect on academic performance of students in computer-assisted cooperative learning. Thus, this shows that computer-assisted instruction enhanced the performance of both male and female students.

Conclusion

The paper has critically examined mathematics and its problems especially within the pupils school level in a rapidly changing world. There is still a wide gap to be bridged in the area of teaching and learning using innovative technology such as CAI in collaborative and individualized environments. The use of computer-assisted instruction in either collaborative or individualized settings seems to be the answer. CCI and ICI were more effective in teaching the mathematical concepts of geometry and are also gender friendly.

Recommendations

Based on the findings of this study, the following recommendations are made.

(i) Since the findings of this study showed that students who worked on the
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computer collaboratively and individually performed better than those taught using conventional teaching method. Teachers should be encouraged to employ collaborative computer to improve pupils' achievement in geometry. In addition, the use of CCI is cost effective because few computers can accommodate many students. A class of 30 would not need only ten computers systems for instructional needs.

(ii) Further empirical studies should be carried out on the use of CCI for instructional purposes on different subjects and at different levels to provide sound basis for the integration of computer in Nigerian primary schools.

(iii) Primary school teachers should be trained on the effective use of computer for individualized and collaborative instruction through seminars, workshops and conferences.

References


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