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EFFECTS OF THREE COOPERATIVE LEARNING STRATEGIES ON THE PERFORMANCE OF SECONDARY SCHOOL STUDENTS IN PHYSICS

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Abstract. This study investigated the effects of three co-operative learning strategies on the performance of secondary students in physics. It also examined whether the performance of the students would vary with gender and achievement levels. Purposive sampling technique was used to select two senior secondary (SSS II) physics students from two intact classes in the selected four secondary schools in Minna, Niger State, Nigeria. The students were in STAD (n = 48), Jigsaw II (n = 42), TAI (n = 41), and ICI (n = 38) groups. Computer-Assisted Learning Package (CALP) and Physics Achievement Test (PAT) were used as treatment and test instruments respectively. Analysis of Covariance and Scheffe test were used for data analysis. Findings indicated that there was significant difference in the performance of the groups. In addition, students' gender had no influence on their performances. Also, achievement levels had significant influence on students' performance in cooperative settings. Based on the findings, it was recommended among other that teachers should be encouraged to use computer-supported cooperative strategies in the classroom for teaching physics concepts.

Keywords: achievement level, gender, computer in education, STAD, TAI, Jigsaw II, ICI

Introduction

In Nigeria, students are introduced to physics at senior secondary school level. The effective teaching and learning of physics is crucial for the better performance of students at Senior Secondary Certificate Examination (SSCE). Equilibrium of forces and Simple Harmonic Motion are ones of the concepts in the physics curriculum for Nigeria senior secondary schools. A review of literature reveals that teachers find these concepts difficult to teach without adequate instructional materials while learners find it difficult to understand (Ogbonna, 1999; Jimoh, 2009). One reason according to Omosewo (2000) and WAEC Chief Examiners' Report 2011-2012 is that most students perceived physics concepts as abstract and involves calculation of mathematical concepts. However, method of teaching adopted by teachers for the teaching these concepts is a major factor respon-

sible for poor understanding and assimilation. The consequential effect is the continual poor performance of physics students in the national and international examinations (Jimoh, 2004; Njoku, 2007). To overcome this problem, there is need to adopt innovative teaching and learning strategies of the 21st century. Among these strategies is computer assisted instruction combined with cooperative learning strategies.

Computer-Assisted Instruction (CAI) is designed normally for individual learning, but it has been found to be more effective with small groups than individual alone (Fajola, 2000; Yusuf & Afolabi, 2010). The use of computer as a medium for cooperative learning is referred to as computer-supported cooperative learning and it has been embraced in developed nations (Hooper, 1992; Hopper et al., 1993; Johnson et al., 1996; Mevarech, 1993; Xin, 1999). Research findings indicate that computer-supported cooperative learning improves students' learning and increases their academic achievement, problem solving skills, and task-related, student-student interaction. Studies carried out on CAI concluded that it improved the academic performance of the learners (Gambari, 2004; Tekos & Solomonidou, 2009; Yusuf & Afolabi, 2010). Students using CAI in cooperative learning settings performed better than students using the same programme individually (Fajola, 2000; Yusuf & Afolabi, 2010, Yusuf et al., 2012). In a cooperative setting, students work together to attain group goals that cannot be obtained by working individually or by working competitively. In such classroom structure, students discuss subject matter, help each other learn, and provide encouragement for members of the group (Johnson et al., 1994). Lessons in the cooperative learning strategy are arranged so that each student, ranging from the fastest to the slowest learner, has a contribution to make (Sapon-Shevin & Schniedewind, 1990). There are many cooperative learning strategies that are designed to achieve different objectives. Out of the several cooperative learning strategies, the following six strategies had received attention and have been well researched and found to be effective: Learning Together (LT); Group Investigation (GI); Jigsaw Procedure (JP); Student Teams Achievement Divisions (STAD); Team Assisted Instruction/Individualization (TAI); and Cooperative Integrated Reading and Composition (CIRC) (Johnson & Johnson, 1994, Gambari, 2010).

The key elements of cooperative learning include: positive interdependence where each student must believe that they have a key role to play in the group; individual accountability where each student within a group must be accountable for mastery of the instructional content presented; group rewards that entails sufficient incentives for the group to work together; and group training where students cannot be placed together in a group situation and expected to cooperate without their being taught the social skills needed for collaboration (Slavin, 1996).

In this study, computer-assisted STAD was used. Students were assigned to three-member learning teams that are mixed in achievement level and gender. The

computer presents a lesson, and then students work within their teams to make sure that all team members have mastered the lesson. Finally, all students take individual quiz and group quizzes on the material. During individual quiz, they are not allowed to help one another while they worked together to produce an answer sheet during group quiz. Students' scores are then summed to form team scores, and teams that met certain criteria earn certificates or other rewards (Gambari, 2010).

Studies had proven that computer-supported STAD cooperative learning setting has been effective in promoting students' achievements, encouraging students' interaction and developing their positive attitudes towards learning outcomes in various subjects. Fajola (2000), Pandian (2004), Yusuf & Afolabi (2010), Yusuf et al. (2012) reported that students in the cooperative computer-assisted instruction group showed remarkable post-test mean differences over their respective counterparts who learned the same concepts through traditional method. Similarly, Taiwo (2008) reported that students taught mathematics using computer-assisted cooperative learning strategy performed better than those taught with traditional method. However, Armstrong & Palmer (1998) and Glassman (1989) found no significant difference in the achievement of students taught using STAD and those taught with conventional classroom.

Jigsaw II is a cooperative learning strategy that enables each students of a "home" group to specialize in one aspect of a learning unit. Students meet with members from groups who assigned with same material and form "expert" group, and after mastering the material, they return to the "home" group and teach the material to their group members. The purpose of Jigsaw II is to develop teamwork and cooperative learning skills within all students. In addition, it helps develop a depth of knowledge not possible if the students were to try and learn all of the material on their own. Finally, because students are required to present their findings to the home group, jigsaw learning will often disclose a student's own understanding of a concept as well as reveal any misunderstanding (Simsek, 2013).

Several studies revealed that Jigsaw II enhanced better performance among students in physics. For instance, Gambari (2010), Keramati (2010), Hanze & Berger (2007), Berger & Hanze (2009) reported that Jigsaw II was more effective than individualistic and conventional classroom instruction respectively. However, Hanze & Berger (2007), Sherman (2006) and Shaaban (2006) found no significant difference in the achievement of students taught physics using Jigsaw and those taught using conventional classroom and discussion methods respectively. Therefore, findings on the use of Jigsaw cooperative learning is inconclusive, therefore, part of this study examined the effects of computer-supported Jigsaw II on students' performance in physics.

Team Assisted Individualization (TAI) is a cooperative learning strategy where students were assigned into three-member heterogeneous group. Each teammate work

individually and cooperatively. They were given the same material but worked at their own pace. Teammate assists one another to understand the material and perform the task collectively. They must help one another for the team to succeed, "they either swim or sink together". Various evaluations of TAI have shown positive effects on mathematics achievement. For examples, Tarim & Akdeniz (2007) and Gupta & Pasrija (2011) found supremacy of TAI cooperative learning strategy over traditional method of teaching in achievement and retention. In a study on computer-supported TAI cooperative learning, Xin (1996) found an improvement in students' achievement and positive attitudes toward mathematics. However, Karper & Melnick (1993) found no significant differences between students taught Mathematics using TAI and those taught with conventional method. Similarly, Slavin & Karweit (1984) found that students in TAI performed better than those in control group in Mathematics computation achievement, but no significant difference was found between those in TAI and individualized instruction groups. Meanwhile in the second study, it was found that TAI students scored significantly higher than control students in Mathematics computation.

Gender has been identified as one of the factors influencing students' achievement in sciences at senior secondary school level. Olson (2002) reported females performed better than male students when taught mathematics using cooperative learning. Contrarily, Aguele & Agwugah (2007), Adeyemi (2008), Kolawole (2007) and Khairulanuar et al. (2010) found gender differences in favour of male students. On the other hand, Annetta et al. (2009), Ajaja & Eravwoke (2010), Gambari, 2010, Kost et al. (2009) and Yusuf & Afolabi (2010) reported that gender had no effect on academic performance of students in cooperative learning. These contradictory findings have caused for inclusion of gender as one of the moderating variable or this study.

The issue of learners' achievement levels influence on students' academic performance has attracted the attention of researchers. Slavin (1996) identified that cooperative learning has been linked to increase in the academic achievement of learners at all ability levels. Fajola (2000) and Balfakih (2003) reported significant difference between students of high, medium and low ability level in favour of high and medium respectively. Iqbal (2004) reported no significant difference between the mean scores of high achievers of the experimental and the control groups. However, Yusuf (2004) revealed that achievement levels had no influence on academic performance of the learners. Other studies have found that high, medium and low achievers were favoured in cooperative learning settings (Yager et al., 1985).

There are many cooperative learning strategies that could be suitable for science-oriented courses. Teachers in the developed world are often confused about which of these strategies to use or employ in the teaching of students in any particular course while teachers' in Nigeria have low awareness of these strategies (Gambari, 2010). Empirical

studies on the effect of cooperative learning strategies within Nigeria context are very scanty. There is controversy surrounding the cooperative setting that best suitable for classroom instruction. The question is, which of these cooperative setting is suitable for Nigerian science students especially physics? Is it Jigsaw II or STAD or TAI? Therefore, this study investigated the effects of computer-supported STAD, Jigsaw II and TAI co-operative learning strategy on the performance of secondary school students in physic.

Research questions

The study addressed the following research questions: (i) what are the differences in the performance of students taught physics using computer-supported STAD, Jigsaw II, and TAI cooperative settings; (ii) is there any difference in the performance of male and female students taught physics using computer-supported STAD, Jigsaw II and TAI cooperative settings; (iii) what are the differences in the achievement levels (high, medium & low) of students taught physics using computer-supported STAD, Jigsaw II, and TAI cooperative settings; (iv) what are the interaction effects on treatment, achievement level and gender on the performance of physics students.

Research hypotheses

The following null hypotheses were tested in the study: (i) there are no significant differences in the performance of students taught physics using computer-supported STAD, Jigsaw II, and TAI cooperative settings; (ii) there are no significant differences in the performance of male and female students taught physics using computer-supported STAD, Jigsaw II and TAI cooperative settings; (iii) there are no significant difference in the achievement levels of (high, medium & low) students taught physics using computer-supported STAD, Jigsaw II, and TAI cooperative settings; (iv) there are no interaction effects on treatment, achievement level and gender on the performance of physics students.

Methodology

Sample

A quasi-experimental study of a non-randomized, non-equivalent, pre-test, post-test, and control group design was employed in this study. 167 second year physics students from four intact classes of different co-education secondary schools in Minna, Niger State, Nigeria participated in the study. The schools were purposively sampled based on six criteria: (i) equivalence (laboratories, facilities and manpower); (ii) school ownership (public schools); (iii) gender composition (mixed schools); (iv) ICT facilities (computer laboratories under the School Net programme); and (v) candidates' enrolment (Senior Secondary School Certificate in Education in physics for a minimum of ten years). The

schools were randomly assigned to experimental groups I, II and III (computer-supported Jigsaw II, STAD & TAI) and control (ICI) groups using simple random sampling technique. The experimental group I (n = 46) was taught using computer-supported STAD cooperative learning strategy, the experimental group II (n = 42) was taught through computer-supported Jigsaw II cooperative learning strategy, and experimental group III (n = 41) was exposed to computer-supported TAI cooperative learning strategy, while control group (n = 38) was taught using ICI for six weeks. The data was collected through the Physics Achievement Test, Physics Attitude Scale (PAS), while CSCL was used as a treatment instrument.

Instruments

(i) *Physics Achievement Test (PAT)* consists of 100 multiple-choice questions, adopted from past examination of West African Examination Council (WAEC, May/June, 1988-2008) and National Examination Council (NECO, June/July, 2000-2009). The questions in the test were based on the contents of the CALP package. Each of the stems of the PAT had four options (A-D). This instrument (PAT) was administered to the experimental and control groups as pre-test and post-test after it had been reshuffled. This test was validated by experts before administered on 40 randomly selected SSII students who were not part of the study. Reliability coefficient of 0.90 was obtained using Kuder Richardson (KR-21).

(ii) *Computer Assisted Learning Package (CALP)* was the treatment instrument, used at two different instructional settings (cooperative and individualised). The CALP was developed by the researchers and a programmer using "Macromedia Dreamweaver 8" as the overall platform. Other computer programmes and applications that were also utilized during the development process are Microsoft Word, Macromedia Fireworks 8, and Macromedia Flash 8. Macromedia Fireworks was used for specific texts, graphics and buttons, while Macromedia Flash was used for simulation. The package was validated by computer programmers and educational technology experts; subject content (physics) specialists; and finally validated by 40 sampled students from a school within the population but not partake in the study. The package contained of two topics which were subdivided into sixteen lessons. The main menu of the package consisted of introduction, students' registration, list of lessons as in lesson 1, 2, 3, 4, … 16 and exit. It adopted the drill and practice modes of CAI.

Experimental procedure

In collecting the data for this research, the objectives and the modalities of the study were specified and operational guide was produced before the commencement of the treatment. Physics teachers in the experimental group were trained in the use of the

computer-assisted learning package and cooperative learning strategies while teacher in the control group was trained on how to coordinate individualised computer instruction using CALP package. The treatment period for all groups covered six weeks (two hours forty minutes per week). The students in the experimental groups were heterogeneously divided into groups with three members each. To avoid bias in grouping, team portrait, team vision statement, classmate scavenger hunt, and card sort team building structures were used in each school, respectively.

At the beginning of the study, PAT was administered on students in the sampled schools as pre-test. The CALP package was installed on standalone computer systems in all the selected schools. The physics contents were presented through the computer and the learners interact and respond to the computer prompts. The computer presents information and display animation to the learner on each of the unit after which students attempted some multiple-choice questions. The students could only proceed further in a lesson on the condition that the questions were satisfactorily answered. The students must have had at least 100% mastery of one topic before moving on to the next. If after three attempts they do not get the answer correctly, the package immediately logs them out and the instructor had to be called before they could continue through another log-in. During the study, the experimental groups were exposed to the use of computer-assisted cooperative learning strategies (Jigsaw II, STAD, & TAI) as treatment, while students in control group were individually exposed to the computer assisted instructional package. Immediately after the treatment, PAT was administered as post-test and after four weeks, it was re-administered as retention test.

Procedures for each strategy

(i) The computer-supported STAD cooperative learning strategy: STAD is the simplest cooperative learning strategy. In this method, 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 CSCL package 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) The computer-supported Jigsaw II cooperative learning strategy: In this strategy, students were divided into small heterogeneous groups called home groups, with three members in each group. Each member was assigned different responsibilities. Initially all students are assigned to study and understand the basic concepts of the materials. After this process, the researcher divided the content (the tasks) of the lesson into three and assigned it to each member in the home group. The students met in their home groups and study the assigned tasks using CSCL package. Each individual member in the home group attempted learning the assigned task as an expert by referring to the computer package and the available resources. After completing the learning task in the home group, each member moved into expert group (Jigsaw II group) consisting of members from the other home groups who had been assigned the same portion of the material (task). In the Jigsaw II group (expert group), the participants discussed and shared their particular materials with other members of the group and discuss how to teach it to their members in the home group. The teammates returned to their home groups where they taught what they learned from the Jigsaw group to other members of their groups. In case of any difficulty and misconception, the expert group made second round meeting to discuss and clarify their doubts if any; and returned to their home groups, to re-teach the members and reach a consensus. The group processing and scoring method is the same with the STAD. High scoring teams were recognised and rewarded in the class.

(iii) The computer-supported TAI cooperative learning strategy: TAI was designed for teaching mathematics, but in this study it was adopted for physics since both have many things in common. In this strategy, students were divided into three member heterogeneous groups. Each student was assigned to a standalone computer on individualised bases, and then proceeds at his/her own pace. In other words, team member study the same concept independently but they moved round to seek for assistance from teammates and checked each other's work on worksheets and help one another to understand the concepts and solve the problems. Individual quiz was given to teammates but final unit test was taken without help from group members and scored by the researchers. The scored obtained by individual and group tests were summed and finds the average. Then certificates or other team rewards was given to the best team.

(iv) Individualized Computer Instruction method: In this method, students were taught the physics concepts using CALP package only. The computer presented the instruction on human-to-computer basis. Students proceeded with the physics contents and study at their own rate without any assistance from their colleagues. Students answered the PAT test at pre-test and post-test individually.

Results

To test for the hypotheses, the data were analysed using Analysis of Covariance (ANCOVA) and Scheffe's test using Statistical Package for Social Sciences (SPSS) version 16 at 0.05 alpha level. The results are presented based on the research hypotheses.

Hypothesis One: There is no significant difference in the performance of secondary school students taught physics using computer-supported STAD, Jigsaw II, and TAI in cooperative settings, and those taught using individualised computer instruction (ICI).

To determine whether there was significant difference in the post-test mean scores of computer-supported STAD, Jigsaw II, and TAI groups, and control group (individualised computer instruction), data were analyzed using the analysis of covariance (ANCOVA). Table 1 shows the result of the analysis.

Table 1. ANCOVA post-test on STAD, Jigsaw II, TAI and ICI groups

Source of Variation	Sum of Square	df	Mean Square	F	Significance of F
Covariate (Pre-test)	1617.995	1	1617.995	36.142	0.000
Main Effect (Treatment)	1201.642	3	400.547	8.947	0.000
Model	2783.969	4	695.992	15.547	0.000
Residual	7252.342	162	44.768		
Total	706799.000	167			

Table 1 reveals that an F (3, 162) = 8.947, p = 0.000 for the main effect (treatment) was significant, this indicates that the method of instruction produced a significant effect on the post-test achievement scores of students when covariate effect (pre-test) was controlled. The results indicate that the treatment, using STAD, Jigsaw II, TAI and ICI accounted for the difference in the post-test achievement scores of the students. Based on the established significant difference in the post-test achievement scores of the groups, Scheffe's test was used for post-hoc analysis. The results of this post-hoc analysis are as shown in Table 2.

The result in Table 2 indicates that there was no significant difference in the posttest mean scores of students exposed to STAD (X = 65.43) and those exposed to Jigsaw II (X = 68.38). It also indicates no significant difference in the posttest mean scores of students exposed to Jigsaw II (X = 68.38) and those exposed to TAI (X = 62.73). Significant difference was not established in the posttest mean scores of students exposed to TAI (X = 62.73) and those exposed to ICI (X = 61.39). Significant difference was established between Jigsaw II (X = 68.38) and TAI (X = 62.73), Jigsaw II (X = 68.38) and ICI (X = 61.39) in favour of Jigsaw II.

Table 2. Scheffe's post-hoc analyses of the groups mean scores

Groups	Mean Scores	Group I (STAD)	Group II (Jigsaw II)	Group III (TAI)	Group IV (ICI)
Group I (STAD)	65.43		0.324	0.408	0.1054
Group II (Jigsaw II)	68.38	0.324		*0.008	*0.001
Group III (TAI)	62.73	0.408	*0.008		0.885
Group IV (ICI)	61.39	0.105	*0.001	0.885	

** The mean difference is significant at the 0.05 level.*

Hypothesis Two: There are no significant difference in the performance of male and female students taught physics using computer-supported STAD, Jigsaw II and TAI cooperative settings.

To determine whether there was significant difference between male and female using computer supported STAD, Jigsaw II, and TAI groups, data were analyzed using the analysis of covariance (ANCOVA). Tables 3-5 show the result of the analysis.

Table 3. ANCOVA result of male and female students in computer-assisted STAD group

Source of Variation	Sum of Square	df	Mean Square	F	Significance of F
Covariate (Pretest)	129.013	1	129.013	2.536	0.119
Main Effect (Gender)	14.557	1	14.557	0.287	0.595
Model	135.862	2	67.931	1.335	0.274
Residual	2187.443	43	50.871		
Total	264082.000	46			

The analysis in Table 3 shows that the main effect of treatment group 1 (computer-assisted STAD) on gender produced an F (1, 43) = 0.286, p = 0.595. This indicates that there was no significant difference in the performance of male and female students taught using computer-assisted STAD on physics. This result was not significant at the 0.05 alpha level. Hypothesis two was therefore not rejected. This implies that male students' achievement did not differ significantly from that of their female counterparts when both were taught using computer-assisted STAD cooperative learning strategy.

Table 4. ANCOVA result on male and female students in computer-assisted Jigsaw II group

Source of Variation	Sum of Square	df	Mean Square	F	Significance of F
Covariate (Pretest)	189.678	1	189.678	4.499	0.040
Main Effect (Gender)	20.725	1	20.725	0.492	0.487
Model	247.964	2	123.982	2.941	0.065
Residual	1644.322	39	42.162		
Total	260236.000	42			

Table 4 indicates that the main effect of treatment (group 2 – computer-assisted Jigsaw II) on gender produced an F (1, 39) = 0.492, p = 0.487 which was not significant at 0.05 alpha level. This shows that there was no significant difference between the posttest means scores of male and female students. Male students' scores did not differ significantly from their female counterparts when both were taught using computer-assisted Jigsaw II cooperative learning strategy. Therefore, hypothesis two was not rejected.

Table 5. ANCOVA result on male and female students in computer-assisted TAI group

Source of Variation	Sum of Square	df	Mean Square	F	Significance of F
Covariate (Pretest)	1434.483	1	1434.483	78.438	0.000
Main Effect (Gender)	0.439	1	0.439	0.024	0.878
Model	1495.103	2	747.551	40.876	0.000
Residual	694.946	38	18.288		
Total	163536.000	41			

Table 5 indicates that the main effect of treatment (Group 3 – Computer-Assisted TAI) on gender produced an F (1, 38) = 0.024, P = 0.878 which was not significant at 0.05 alpha level. This shows that there was no significant difference between the post-test means scores of male and female students. Male students' scores did not differ significantly from the female students' scores when both were taught using TAI. Therefore, the hypothesis was not rejected.

*Hypothesis Three***:** There are no significant differences in the achievement levels of (high, medium & low) students taught physics using computer-supported STAD, Jigsaw II, and TAI cooperative settings.

To determine whether there were significant differences among high, medium and low achievers using computer supported STAD, Jigsaw II, and TAI groups, data were analyzed using the analysis of covariance (ANCOVA). Tables 6A & 6B; 7A & 7B; and 8A & 8B show the result of the analyses.

Table 6A. ANCOVA result of high, medium and low achievement students in computer-assisted STAD

Source of Variation	Sum of Square	df	Mean Square	F	Significance of F
Covariate (Pretest)	16.584	1	16.584	1.579	0.216
Main Effect(Level)	1760.946	2	880.473	83.841	0.000
Model	1882.231	3	627.410	59.743	0.000
Residual	441.073	42	10.502		
Total	264082.000	46			

The result of the analysis in Table 6A indicates that an F (2, 42) = 83.841, p = 0.000 for the main effect was significant at 0.05 alpha level. This implies that there was significant difference in the posttest mean scores of the high, medium and low achievers students. This signifies that the use of computer-assisted STAD was influenced by the achievement levels as the initial advantage at the pre-test had been statistically controlled using ANCOVA.

Scheffe test was conducted to determine the direction of difference among the three achievement levels. The result of the analysis is shown in Table 6B.

Table 6B shows significant difference in the mean scores of high achievers (X = 84.25) and medium achievers (X = 75.85) in favour of high achievers. It also indicates that significant difference between medium achievers (X = 75.85) and low achievers (X = 67.29) in favour of medium achievers. Significant difference was established between high achiever (X = 84.25) and low achievers (X = 67.29) in favour of high achievers.

Table 6B. Scheffe's post-hoc analyses of the groups mean scores computer-assisted STAD

Groups	Mean Scores	Group I (High)	Group II (Medium)	Group III (Low)
Group I (High)	84.25		*0.000	*0.000
Group II (Medium)	75.85	*0.000		*0.000
Group III (Low)	67.29	*0.000	*0.000	

** The mean difference is significant at the 0.05 level.*

Therefore, the high achievers perform better than medium achievers and low achievers respectively when exposed computer-assisted STAD cooperative learning. Therefore, hypothesis three was rejected.

To determine the significant differences among high, medium and low achievers using computer supported Jigsaw II, the results is shown in Tables 7A and 7B.

Table 7A. ANCOVA result of high, medium and low achievers in computer-assisted Jigsaw II group

Source of Variation	Sum of Square	df	Mean Square	F	Significance of F
Covariate(Pretest)	18.218	1	18.218	0.905	0.347
Main Effect (Level)	900.465	2	450.232	22.337	0.000
Model	1127.704	3	375.901	18.682	0.000
Residual	764.582	38	20.121		
Total	260236.000	42			

Table 7A indicates that an F (2, 38) = 22.337, p = 0.000 was significant at 0.05 level. This shows significant difference on the main effect (Computer-Assisted Jigsaw II) when achievement levels were considered. The use of computer-assisted Jigsaw II accounted for the differences in the students' achievement scores. Since the existence of differences had been established, Scheffe's post-hoc analysis was used to determine the direction of the difference. The result of the Scheffe's analysis is indicated in Table 7B.

Table 7B. Scheffe's post-hoc analyses of the groups mean scores in computer-assisted computer-assisted Jigsaw II

Groups	Mean Scores	Group I (High)	Group II (Medium)	Group III (Low)
Group I (High)	86.00		*0.001	*0.000
Group II (Medium)	78.65	*0.001		*0.001
Group III (Low)	71.75	*0.000	*0.001	

* The mean difference is significant at the 0.05 level.

The result in Table 7B shows significant differences in the mean scores of high achievers (X = 86.00) and medium achievers (X = 71.75) in favour of high achievers. It also indicates that significant difference between medium achievers (X = 78.65) and low achievers (X = 71.75) in favour of medium achievers. Significant difference was

established between high achiever (X = 86.00) and low achievers (X = 71.75) in favour of high achievers. Thus, the use of computer-assisted Jigsaw II aided high achievers to perform significantly better than the medium achievers and low achievers. Therefore, hypothesis three was rejected.

To determine the significant differences among high, medium and low achievers using computer supported TAI, Tables 8A and 8B shows the analysis of the results.

Table 8A. ANCOVA results of high, medium and low achievers in computer-assisted TAI

Source of Variation	Sum of Square	df	Mean Square	F	Significance of F
Covariate (Pretest)	260.801	1	260.801	17.139	0.000
Main Effect (Level)	132.379	2	66.189	4.350	0.020
Model	1627.042	3	542.347	35.642	0.000
Residual	563.007	37	15.216		
Total	163536.000	41			

The result of the analysis in Table 8A indicates that, an F (2, 37) = 4.350, p = 0.020 for the main effect was significant at 0.05 alpha level. This indicates that there was significant difference in the posttest means scores of the high, medium and low achievers. This signifies that the use of computer-assisted TAI accounted for the difference in the achievement scores as the initial advantage at the pretest had been statistically controlled using ANCOVA.

Based on this result, a post-hoc analysis using Scheffe's test was conducted to determine the direction of differences among the three achievement levels. The result of the analysis is shown in Table 8B.

Table 8B. Scheffe's post-hoc analyses of the groups mean scores in computer-assisted TAI Group

Groups	Mean Scores	Group I (High)	Group II (Medium)	Group III (Low)
Group I (High)	70.23		*0.001	*0.000
Group II (Medium)	62.50	*0.001		*0.003
Group III (Low)	56.00	*0.000	*0.003	

* The mean difference is significant at the 0.05 level.

The result in Table 8B shows significant differences in the mean scores of high achievers (X = 70.23) and medium achievers (X = 62.50) in favour of high achievers. It also reveals significant difference between medium achievers (X = 62.50) and low achievers (X = 56.00) in favour of medium achievers. Significant difference was established between high achiever (X = 70.23) and low achievers (X = 56.00) in favour of high achievers. Thus, the use of computer-assisted TAI significantly helped the high achievers to perform better than the medium achievers and low achievers respectively. Therefore, hypothesis three was rejected.

Hypothesis Four: There are no interaction effects on treatment, achievement level and gender on the performance of physics students.

To determine whether there were interaction effects on treatment, achievement level and gender on the performance of physics students, data were analyzed using the analysis of covariance (ANCOVA) as showed in Table 9.

From Table 9, the result shows that there was significant main effect of the treatment when gender and achievement level are combined F (3,162) = 199.62, p = 0.000 for the main effect was significant at 0.05 alpha level. The analysis also revealed significant main effect of achievement level F (2, 162) = 138.28, p = 0.000. However, gender F (1, 162) = 1.44, p = 0.231 had no effect on students' performance. In other words, the treatment of the student had independent effects on the students' performance.

Table 9. ANCOVA results on interaction effects on treatment, achievement level and gender

Source of Variation	Sum of Square	df	Mean Square	F	Significance of F
Posttest covariates pretest	110.391	1	110.391	7.666	0.006
Main effects (combined)					
Treatment	8623.355	3	2874.452	199.624	0.000
Gender	20.796	1	20.796	1.444	0.231
Level	3982.389	2	1991.195	138.284	0.000
2-way interactions (Combined)					
Treatment*Gender	89.596	3	29.865	2.074	0.106
Treatment*Level	170.893	6	28.482	1.978	0.073
Gender*Level	124.993	2	62.496	4.340	0.015
3-way interactions					

Source of Variation	*Sum of Square*	*df*	*Mean Square*	*F*	*Significance of F*
Treatment*Gender*Level	158.074	6	26.346	1.830	0.097
Model	16137.650	24	672.402	46.697	0.000
Residual	2044.709	162	14.399		
Total	833545.000	167			

The analysis shows that there was no significant interaction effect on students' performance in physics as shown in Table 9.

A. Treatment versus gender F (3,162) = 2.07, p = 0.106
B. Treatment versus achievement level F (6,162) = 1.98, p = 0.073
C. Gender versus achievement level F (2, 162) = 4.34, p = 0.015

The analysis also revealed that there was no significant 3 way interaction effects F (6, 162) = 1.83, p = 0.097 of treatment, gender and achievement level of students. This implies that there was no significant joint interaction effect of the independent variables (treatment, gender and achievement level) on the performance of the students.

Discussion of findings

The results of hypothesis one reveals that there is significant difference on students performance in favour of the groups exposed to cooperative learning strategies and those exposed to ICI. Findings indicate significant difference between the performance of students exposed to Jigsaw II and TAI, between Jigsaw II and ICI, between STAD and TAI, and between STAD and ICI. The findings as regards better performance of students in the Jigsaw II and STAD as compared to ICI agrees with earlier findings of Fajola (2000) and Keramati (2010) which established better performance of students taught in cooperative learning settings compared to students using the conventional teaching methods. It also agrees with the findings of Yusuf & Afolabi (2010) in biology which reported that students taught using computer-supported CAI performed better than those taught using computer-assisted instruction in individualised setting. Furthermore, these findings are supported by the findings of Lai & Wu (2006) in nursing education, Moreno (2009) in botany, Doymus (2008) in chemistry which found that Jigsaw II is more effective than other cooperative instructional strategies. The findings as regards better performance of students in the Jigsaw II and STAD as compared to the TAI contradicts the finding of Tarim & Akdeniz (2008) who found that students taught using TAI performed better than those taught using STAD cooperative strategy. No significant difference was established between the TAI and ICI groups contradict the findings of Fajola (2000) and Yusuf & Afolabi (2010).

The superiority of Jigsaw II and STAD over other two strategies, stems from the fact that they are task structured (task specialization) and incentive structured, this could be responsible for the superiority.

The results of the analyses related to the hypotheses two indicated no significant difference in the performance of male and female students taught physics using computer-supported Jigsaw II cooperative learning. The findings as regards the performance of male and female students in the STAD group agree with the earlier findings of Balfakih (2003), Adeyemi (2008) and Kost et al. (2009) which found no significant difference between male and female students' performance when taught using cooperative learning strategy. Furthermore, it supports the findings of Pandian (2004) and Yusuf & Afolabi (2010) which reported that gender did not express any significant influence on biology achievement using computer-assisted STAD cooperative learning strategy. However, it disagrees with the findings of Fajola (2000), Ghaith (2001), Aguele & Agwugah (2007), Kolawole (2007) and Khairulanuar et al. (2010) in their studies that male students performed better than female students in the cognitive, affective and psychomotor skill achievements. It also disagree with the findings of Olson (2002) which found that female students taught mathematics using cooperative learning outperformed their male counterparts.

The results of the analyses related to the hypothesis three indicated significant difference in the performance of high, medium and low students taught physics using computer-assisted STAD cooperative learning. The findings agree with the earlier findings of Fajola (2000), Ghaith (2001) and Balfakih (2003) which found that the high achiever students performed better than the low achiever students. However, it contradicts the findings of Yusuf (2004) which revealed that achievement levels had no influence on academic performance of the learners.

These findings have strong implications for teaching and learning of physics in secondary schools in Nigeria using computer-supported cooperative learning strategies. Major implication of these findings is that computer-assisted instruction is better in cooperative learning settings than individualized setting. Furthermore, the findings provide sound empirical basis which indicate that performance of physics students would be greatly improved if students are exposed to varieties of computer-supported cooperative learning strategies.

Conclusion

The study has critically examined the relevant literature on three types of computer-supported cooperative learning strategies, their peculiarities, and empirical evidences. The influence of gender and achievement levels as it affects students performances in cooperative learning were also reported this study. The author views that computer-supported cooperative learning is an innovative teaching strategies in Nigeria. Its adoption into Nigeria classroom seems to be the answer to poor performance in physics at senior secondary school in Nigeria. Therefore, STAD and Jigsaw II computer-supported cooperative strategies were more effective in teaching the Equilibrium of forces and Simple Harmonic Motion concept of physics.

Recommendation

It is recommended that physics teachers should expose their students to computer-supported Jigsaw II and STAD cooperative instructional strategies in order to improve their performance in physics, social interaction, active learning, and discovery learning among their peers. This could be achieved if physics teachers should be trained on the effective use of computer-supported cooperative learning strategies for instruction through seminars, workshops and conferences. Training and workshop should be organized to create awareness and techniques required in implementing cooperative learning in Nigeria.

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