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Effectiveness of Computer-Supported Cooperative Learning Strategies in Learning Physics

By

[1]Mudasiru Olalere Yusuf, [2]Isiaka Amosa Gambari and [3]Charles Olubode Olumorin
[1]Department of Science Education, Faculty of Education, University of Ilorin, Nigeria
[2]Department of Science Education, Federal University of Technology, Minna, Nigeria
[3]Department of Science Education, Faculty of Education, University of Ilorin, Nigeria

Abstract

This study investigated the impact of varied types of instructional delivery strategies in computer-supported cooperative learning (STAD, Jigsaw II, and TAI) and independent Computer Assisted Instruction (CAI) settings on senior secondary students' performance in physics. It also examined if the performance of the students would vary with gender and academic ability levels. Participants were 167 senior secondary II physics students drawn from four intact classes in Minna, Niger State, Nigeria. Computer-Assisted Instruction Package (CAIP) developed specifically on equilibrium of forces and simple harmonic motion was used as treatment material. Analysis of Covariance and Scheffe test were used for data analysis. Findings indicated that learning in computer-supported STAD and Jigsaw settings enhanced students' performance in physics. Similarly, students' academic levels had significant influence on their performance; however, students' gender had no influence on their performance. This study strengthens the using CAI in cooperative settings and this has implications for the successful integration computer in instruction.

Keywords: *Computer-supported cooperative learning, Computer assisted instruction, Physics, Nigeria, Secondary schools*

1. Introduction

The importance of physics in science and technology cannot be over emphasized. Physics is applied to almost every human activity because every profession involves some elements of physics. The importance of physics made its inclusion in the Nigerian senior secondary school curriculum imperative. For solid technological foundation and development, physics education needs to be given attention and priority in a nation's educational system. In spite of the importance of physics as a requirement for many specialized science and engineering courses at the tertiary educational institutions students' performance at the secondary school level (high school) in Nigeria has not been encouraging. The performance of students in physics in the Senior School Certificate Examinations (SSCE) in Nigeria from 2004 to 2008 has been poor. The percentage of students that passed physics at credit and above levels (A1 - C6) had consistently being less than 50% (West African Examination Council [WAEC] Report, 2008). Researchers have identified causes of students' poor performance in science subjects; particularly physics, to include poor teaching methods, abstract nature of science concepts, lack of qualified teachers, poor infrastructure and inadequate laboratory facilities, teacher-centered instruction, and non-availability and non-utilization of instructional materials (Bajah, 2000; Gambari, 2010; Olorukooba, 2007). Some science teaching strategies have been established to be effective and efficient in promoting and maximizing science learning outcomes. Such strategies include cooperative learning (Hanze & Berger, 2007; Doymus, 2008); and computer-assisted instruction (Tekos & Solomonidou, 2009; Yusuf & Afolabi, 2010), among others. In spite of the proofed efficiency of these strategies they are rarely used in Nigerian science classrooms.

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 (Johnson & Johnson, 2008). The use of computer as a medium for collaborative learning is referred to as computer-supported cooperative learning and it has been embraced in developed nations (Hooper, 1992; Hopper, Temiyakan, & Williams, 1993; Johnson & Johnson, 2008, Johnson, Johnson & Stanne, 1996; Mevarech, 1993; Schmidt, 2002, Xin, 1996). 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 & Mogbo, 2006; 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).

In a cooperative learning setting, students work together to attain group goals instead of working individually or competitively. Students discuss subject matter, help each other learn, and provide encouragement for members of the group. 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, 1995).

When students work collaboratively they develop learning skills in interpersonal communication, conflict resolution, group problem solving, and group decision making, which are essential skill for the contemporary business world (Kinlaw, 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 in enhancing students' learning. These are: 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).

Studies have proven that cooperative learning setting has been very effective in encouraging students' interaction and developing positive attitudes towards learning (Artut & Tarim, 2007; Jansoon, Somsook, & Coll, 2008; Moreno, 2009). Doymus (2008) and Moreno (2009) reported that Jigsaw II is considerably more effective than individualistic instructional strategy and conventional classroom instruction. However, Thompson and Pledger (1998) found no significant difference in the achievement of students taught using Jigsaw II and those taught using conventional classroom and discussion methods. Ayhan and Yasemin (2006) study revealed that STAD had positive effects on learners' academic performance than traditional classroom instruction. Chunamthiang (1998) found TAI cooperative learning strategy to be more effective than conventional classroom instruction. Also, Keramati (2010) finding indicated that the performance of students taught in cooperative learning setting was significant better than those taught using the conventional teaching method.

The affinity and links between technology and cooperative learning had been highlighted by Millis and Cottell (1998) as they noted that cooperative learning and technology are natural partners because the use of technology involves human dimensions of caring, community, and commitment. In computer supported learning environment Stahl, Koschmann, and Suthers (2006) had noted the "focus [is] no longer on what might be taking place in the heads of individual learners, but what [is] taking place between them in their interactions" (p. 415). The use of technology in ways that promote sequenced learning within groups can lead to in-depth processing of course content and, hence, more retention of information (Newberry, 1999). Thus, students' learning can be enhanced when technology promotes cooperation and establishes shared experience (Johnson & Johnson, 2008).

Gender has been identified as one of the factors influencing students' performance in sciences at senior secondary school level. Derbyshire's (2003) review established that girls are less confident than boys in their computer skills, and some international studies have found that boys scored better than girls on computer related knowledge and skills in vast majority of countries. Also, computer related occupations (computer scientists, computer engineers, system analysts, etc.) are the top career choices for boys. Similarly, female users compared with males are more inclined to hold negative reactions to computers thus resulting in different ways of using the computer (Jackson, Ervin, Gardner, & Schmitt, 2001). Khairulanuar, Nazre, Sairabanu, and Norasikin (2010) study on the effects of training method and gender on students' learning of two and three dimensional geometry discovered that gender difference existed as boys generally achieved higher geometrical understanding compared to girls. In addition, there were interaction effects between method of training and gender in favor of boys; however, animation condition was gender-neutral. In a study on gender influence on collaborative use of computer based communication the group with minority women had low index of collaboration compared to homogenous group and group with majority women (Collazos, Guerrero, Llana, & Oetzel, 2002.). However, Olson (2002) reported that individual course grades were higher for females than males taught mathematics in cooperative learning setting. On the other hand, other studies have reported that gender had no effect on academic performance of students (Adeyemi, 2008, Annetta, Mangrum, Holmes, Collazo, & Cheng, 2009, Kost, Pollock, & Finkelstein, 2009). These contradictory findings have agreement with the earlier conclusion of Kirkpatrick and Cuban (1998) that when female and male students at all levels of education had the same amount and types of experiences on computers female achievement scores and attitudes are similar in computer classes and classes using computer.

The issue of learners' academic ability influence on their performance has attracted the attention of researchers. Warring, Johnson, Geoffrey and Johnson (1985) revealed that students' academic ability levels have influence on their academic performance. Hooper and Hannafin (2006) found that cooperation was significantly related to achievement for heterogeneous ability groups, although students of high ability level performed better than students at the medium and low ability levels. Other studies have found that high, medium and low academic ability levels students were favored in cooperative learning settings (Yager, Johnson, & Johnson, 1985). However, Yusuf (2004) revealed that achievement levels had no influence on academic performance of the learners in cooperative and competitive learning settings, as the performance of students in the high, medium and ability groups was not significantly different. These contradictory findings indicate that research is not yet conclusive on the impact of ability levels on the performance of students taught in cooperative learning settings.

The instructional values of cooperative strategies have been established, however, the extent of the effects of these strategies in computer-supported settings on Nigerian students' performance in science is yet to be fully explored. Reviews show the inconclusiveness of the findings on CAI, cooperative learning, gender and academic ability levels on the performance of the learners. Furthermore, it was observed that many of the studies were focused on comparison of the effectiveness of CAI or a particular cooperative learning strategy and conventional classroom instruction without examining the relative effectiveness CAI in cooperative learning settings. Based on these facts the present study examined the effect of computer-supported cooperative learning strategies (JIGSAW II, STAD, and TAI) on secondary school students' performance in physics.

Research Questions

The study addressed the following research questions.

1. Is there any difference in the performance of secondary school students taught physics in computer-supported STAD, Jigsaw II, TAI cooperative settings, and independent (Independent Computer Instruction, ICI) setting?

2. Is there any interaction effects of gender and academic ability levels on the performance of students who were taught physics in computer-supported cooperative learning settings?

Research Hypotheses

The following hypotheses were tested in the study.

1. There is no significant difference in the performance of secondary school students taught physics using computer-supported STAD, Jigsaw II, TAI cooperative settings, and independent (ICI) setting.

2. There are no interaction effects of gender and academic ability levels on the performance of students taught physics in computer-supported cooperative settings.

2. Research Methodology

Research Design

A quasi-experimental design using a 4x3x2 single treatment factorial design was adopted for the research. These involved four levels of independent primary variable (three treatments and control), two levels of gender (male and female) and three academic ability levels (high, medium, and low). Experimental group 1 was subjected to treatment using computer-supported STAD, experimental group 2 was subjected to treatment using computer-supported Jigsaw II, while experimental group 3 was subjected to treatment using computer-supported TAI. The control group was taught using individualized computer instruction (ICI).

Participants

Based on the nature of this research, a three-stage sampling technique was adopted. First, purposive random sampling was used to select four secondary schools in Minna, Niger State, Nigeria. These schools were selected based on the following criteria: equivalence (laboratories, facilities, and manpower), school ownership (public schools), gender composition (mixed schools), ICT facilities (computer laboratories under the national SchoolNet programme), and candidates' enrolment (Senior Secondary School Certificate in Education in physics for a minimum of ten years). Second, one intact class in each of the four schools were selected and randomly assigned to each of the three experimental (STAD, Jigsaw II, TAI) and control (ICI) groups using simple random sampling technique. Third, the researcher arranged the list of elements in the school into different strata based on gender (male & female) and academic ability levels (high, medium, & low). Since the conventional measure of mental ability like Intelligent Quotient (IQ) and Verbal Quotient (VRQ) are not available in Nigerian Secondary Schools (Fajola, 2000; Yusuf, 1997) students were stratified into academic ability levels (high, medium and low) based on their performance in the previous promotion examination in physics. The high academic ability level students in the study were those whose average score in previous school examination in physics fall within the upper 25% (3rd quartile). The medium academic ability level students' scores were within the middle 50%, while students whose scores fall within the lower 25% (1st quartile) were classified as students in low academic ability level.

Research Material and Instrument

i. **Treatment Material**: This is a Computer Assisted Instruction Package (CAIP) for senior secondary physics used at four different instructional settings (cooperative [JIGSAW II, STAD, TAI] and individualized). It was developed by the researchers and a programmer. The CAIP package was developed using "Macromedia Dreamweaver 8" as the overall platform. Other applications that were utilized during the development process are Macromedia Fireworks 8 and Macromedia Flash 8. Macromedia Fireworks was used for specific texts, graphics and buttons, while Macromedia Flash was used for animation. The package was validated by computer programmers, educational technology experts, and subject content (physics) experts. Finally the package was field tested on sample representative similar to the students used for the final study. The package contained two topics (equilibrium of forces and simple harmonic motion) that were subdivided into sixteen lessons. The main menu of the package consisted of introduction, students' registration, list of lessons and exit. It adopted the drill and practice modes of CAI. The main difference between the group-based and the individualized use of the CAI package was the adjustments made in terms of entries of number of the individuals who reacted to the computer.

ii. **Test Instrument**: The instrument used in collecting data for this study was a researcher-adopted Physics Achievement Test (PAT). The PAT consisted of 100 multiple choice objective items adopted from past examination of the West African Examination Council (WAEC, May/June, 1988-2008) and National Examination Council (NECO, June/July, 2000-2007). The Test (PAT) was based on the contents of the CAIP package. Each of the stems of the PAT had five options (A - E) as possible answers to the question. Students were required to indicate correct answers by ticking one of the letters (A - E) that corresponds to the correct option in each item. This instrument (PAT) was administered to the experimental and control groups as pre-test and again for the post-test after it had been rearranged. A score of '1' was awarded for each correct answer and '0' for each wrong answer. Thus, maximum possible score was 100. The test items were validated and tested for reliability using 40 randomly selected SSI students. The test was administered once on the pilot samples. A reliability test using the Kudar Richardson (KR-21) revealed a reliability of 0.90.

Procedure

The researcher visited the selected schools and sought the cooperation of students and staff in selected schools. The physics teachers were then trained as research assistants in the use of the computer-assisted learning package and cooperative learning strategies. The training lasted for one week and it focused on the use of CAI in instruction, elements of cooperative learning, roles of teachers in cooperative settings, using computer assisted learning package in cooperative learning settings; and encouraging students' participation in the use of the computer for learning. The experimental group teachers received specific training designed to equip them with the necessary strategies for implementing treatment, the use of the CALP, how to interact in a cooperative setting, the roles of an individual in the group, rules and regulations guiding the use of cooperative learning strategies to achieve common goal. The control group teacher was trained on how to coordinate individualized computer instruction using the CALP package. The treatment lasted for six weeks.

The students in the experimental groups were heterogeneously divided into groups with three members each composed of students of different gender and different academic ability levels. To avoid bias in grouping, team portrait, team vision statement, classmate scavenger hunt, and card sort team building structure were used in each school. In order to facilitate self-control, learner autonomy, and democracy in the management of groups, two rules were introduced (Ten Commitments & Ten Commandments). These rules were repeated loudly before the lesson in the first week. The purpose of repeating all the rules was for habit formation on self-control, discipline, and learner autonomy. When students got accustomed to the learning climate oral repetition of the rules was stopped. After the formation of heterogeneous groups and the process of teambuilding each member in the group was given a role to play. The designation and rotation of role assignment for each student led to avoidance of free riders or potential complaint of overloading from high achievers.

At the commencement of the experiment PAT was administered on participants as pre-test, thereafter, the treatment which lasted for six weeks followed. The CALP package was installed on standalone computer systems. The physics contents were presented through the computer and the learners interacted and responded to the computer prompts. The computer presents information and displayed animation to the learner on each of the unit after which the 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. The physics teachers assisted by research assistants from each of the four selected schools served as the instructor in the administration of the treatment. During the experiments the experimental groups were exposed to the use of computer-supported cooperative learning strategies (STAD, Jigsaw II and TAI) as treatment, while the control group students were individually exposed to the computer assisted learning package. After the treatment PAT was administered as post-test. Specific group based activities for the groups are further elaborated below.

Experimental Group I**:** Students-Team Achievement Division (STAD) activities.

(i) Students complete the reading of the materials using CALP package;
(ii) Individually students take a CALP package quiz (answer the questions from computer) on the assigned reading;
(iii) Students take the same quiz as a team attempting to reach consensus with respect to the correct answers for all test questions because only one answer sheet must be submitted by the team for which all teammates receive the same 'team score';
(iv) Each student's individual quiz score and team quiz score are counted equally towards the student's final course grade.
(v) High scoring team is recognized and rewarded in the class.

Experimental Group II**:** Jigsaw II cooperative activities.

(i) Students were divided into small heterogeneous groups called home groups with three members in each group. Each member was assigned different responsibilities.
(ii) The teacher listed the tasks for cooperative learning, which was divided into many sections as there were members in each team.
(iii) Instead of each student being assigned a unique section all students were given a common academic work (topics).
(iii) The students met in their home groups and distributed the task among themselves. 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.
(iv) After completing the learning task in the home group each member moved into expert group consisting of members from the other home groups who had been assigned the same portion of the material.
(v) The participants discussed and shared their particular materials with other members of the group.
(vi) The participants returned to their home groups where they taught what they learned from the group to other members of their groups;
(vii) The members made second round meeting in to discuss and clarify their doubts if any.
(viii) Members returned to their home groups to re-teach the members and reach a consensus.
(ix) High scoring teams were recognized and rewarded in the class.

Experimental Group III: Team Assisted Instruction (TAI) activities included the following.

(i) Students were placed on standalone computer on individualized bases and then each student proceeded at his/her pace.
(ii) Members study the same concept independently.
(iii) Teammates sought for assistance from team mates and checked each other's work using worksheets to help one another to solve problems.
(iv) Final unit test was taken without help from group members and scored by the teachers.
(v) Teacher summed up the number of scores obtained by all team members, finds the average, and gave certificates or other team rewards based on laid down criterion.

Control Group**:** Individualized Computer Instruction method was used here. The students were taught the 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. Students answered the PAT test at pre-test and post-test individually.

Data Analysis Procedure

To test for the hypotheses, the data were analyzed using Analysis of Covariance (ANCOVA) and Scheffe test using Statistical Package for Social Sciences (SPSS) version 11 at 0.05 confidence level.

3. Results

The distribution of the sample is as shown in Table 1.

Table 1: Distribution of Participants

Groups	Gender		Academic Ability Levels		
	Male	Female	High	Medium	Low
STAD	19	27	12	20	14
Jigsaw II	25	17	10	20	12
TAI	24	17	13	14	14
ICI	21	17	12	16	10

As shown in Table 1, out of a total of 167 students 46 students were in STAD cooperative learning strategy (Exp. Group 1), 42 were students in Jigsaw II cooperative learning strategy (Exp. Group 2), 41 students in TAI cooperative learning strategy (Exp. Group 3) and 38 students in ICI strategy, the control group. 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 individualized computer instruction.

To determine whether there were significant differences in the post-test mean scores of the computer supported STAD, Jigsaw II, and TAI groups, and the control group (individualized computer instruction), data were analyzed using the analysis of covariance (ANCOVA). Table 2 contains the result of the analysis.

Table 2: ANCOVA on the Post-test Scores of the Groups

Source of Variation	Sum of Square	df	Mean Square	F	Significance of F
Covariate (Pre-test)	110.391	1	110.391	7.666	0.006
Main Effect (Treatment)	8623.355	3	2874.452	199.624	0.000
Model	16137.650	24	672.402	46.697	0.000
Residual	2044.709	142	14.399		
Total	833545.000	167			

Table 2 revealed that an $F(3, 142)=199.624, p<0.05$ 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 result indicated 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 3.

Table 3: Scheffe Post-Hoc Analysis of the Groups Mean Scores

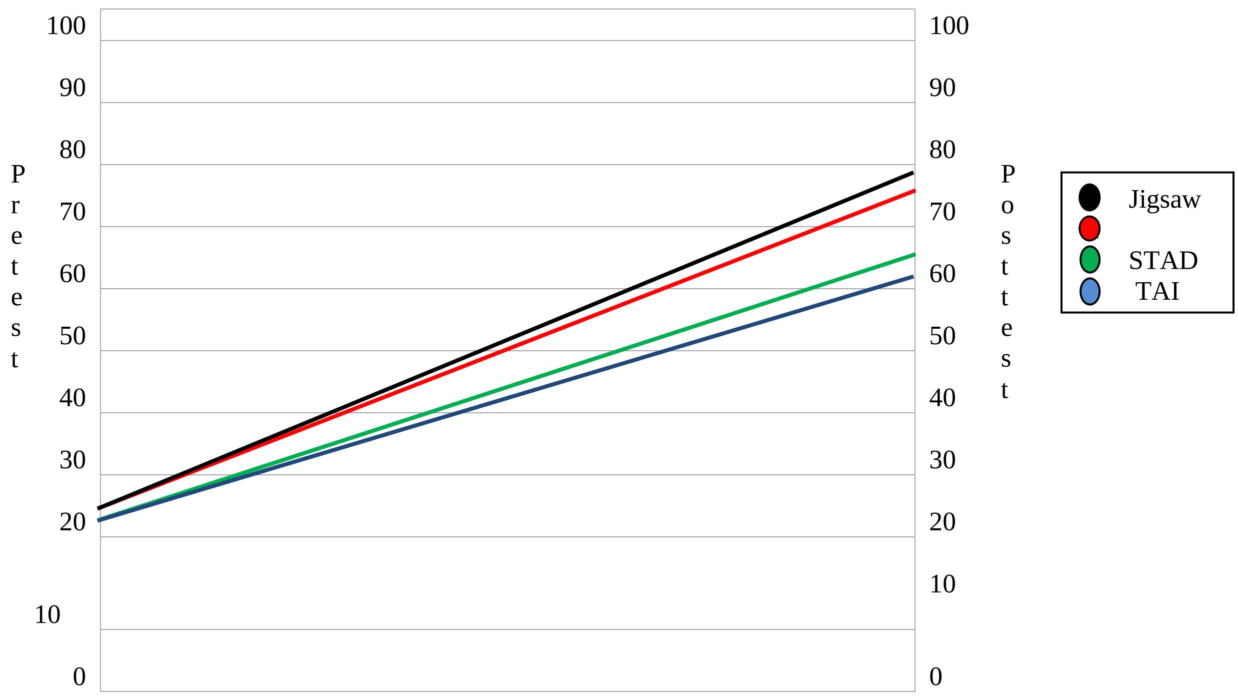
Variable (i)	Variable (j)	Mean Difference	Significance Level
STAD	Jigsaw II	-2.994	0.309
	TAI	12.703*	0.000
	ICI	14.040*	0.000
Jigsaw II	STAD	2.994	0.309
	TAI	15.697*	0.000
	ICI	17.034*	0.000
TAI	STAD	-12.703*	0.000
	Jigsaw II	-15.697*	0.000
	ICI	1.337	0.885
ICI	STAD	-14.040*	0.000
	Jigsaw II	-17.034*	0.000
	TAI	-1.337	0.885

From the Scheffe's analysis on the performance of the four groups in Table 3, it can be deduced that there was significant difference between the post-test mean scores of students taught using Jigsaw II ($\bar{x}$ =78.48) and those taught using TAI ($\bar{x}$ =63.10) and ICI ($\bar{x}$ =60.86) in favour of the Jigsaw II group. Also, the analysis showed significant difference between the mean scores of students taught using STAD ($\bar{x}$ =75.70) and those taught using TAI ($\bar{x}$ =63.10) and ICI ($\bar{x}$ = 60.86) in favour of the STAD group. However, no significant difference was established between students taught using Jigsaw II ($\bar{x}$ =78.48) and STAD ($\bar{x}$ =75.70); and between students taught using TAI ($\bar{x}$ =63.10) and ICI ($\bar{x}$ =60.86). The performances of students in the four groups were further compared based on the mean gain scores between the pre-test and post test for each group and the results are shown in Table 4 graphically illustrated in Figure 1.

Table 4: Mean Gain Scores for Treatment and Control Groups

Groups	Pretest	Posttest	Mean Gain Score
STAD	19.91	75.70	55.79
Jigsaw II	19.90	78.48	58.58
TAI	19.63	63.10	43.47
ICI	19.55	60.86	41.31

From Table 4 it was observed that all the groups had improved performance in post-test. For instance, Jigsaw II had highest mean gain scores of 58.58; STAD had the mean gain scores of 55.79; TAI with the mean gain scores of 43.47, while the (ICI) had the least mean gain scores of 41.31. This indicated that all the groups benefited from the treatment with Jigsaw II having the best performance.



Hypothesis Two

There are no interaction effects of gender and achievement levels on the performance of students taught physics in computer-supported cooperative settings. The results on this hypothesis are as shown in Table 5.

Table 5: Interaction Effects of Treatment, Gender, and Academic Ability Levels

Source of Variation	Sum of Square	Df	Mean Square	F	Sig
Post-test covariates pre-test	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
Academic Ability Levels	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*Academic Ability Levels	170.893	6	28.482	1.978	0.073
Gender*Academic Ability Level	124.993	2	62.496	4.34	0.015
3-way interactions					
Treatment*Gender*Level	158.074	6	26.346	1.83	0.097
Model	16137.650	24	672.402	46.697	0.000
Residual	2044.709	142	14.399		
Total	833545.000	167			

From Table 5 it can be observed that there was significant main effect of the treatment $F(3,142)=199.62, p<0.05$. The analysis also revealed significant interaction effect of achievement levels $F(2,142)=138.28, p< 0.05$. However, gender had no interaction effect on students' performance. The analysis further showed no significant 2-way interaction effect on students' performance in physics based on treatment and gender and treatment and achievement levels. However, significant 2-way interaction effect was established for gender and achievement levels, $F(2,142)=4.34, p<0.05$. The analysis revealed further that there were no significant 3-way interaction effects of treatment, gender and achievement levels. This implies that there was no significant joint interaction effect of the independent variables (treatment, gender and achievement level) on the dependent variable (performance of the students).

4. Discussion of Findings

The results indicated that significant difference existed in students' performance in favour of those in the experimental groups (STAD and JIGSAW II). Findings indicated significant difference between the performances of students exposed to Jigsaw II and TAI, 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 the ICI agree 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 and Afolabi (2010) in biology which reported that students taught using computer-supported CAI performed better than those taught using computer assisted instruction in individualized settings. Furthermore, these findings are supported by the findings of Lai and 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 (experimental group) contradicts the finding of Tarim (2008) who found that students taught using TAI performed better than those taught using STAD cooperative strategy. The no significant difference established between the TAI and ICI groups contradicts the findings of Fajola (2000) and Yusuf and Afolabi (2010).

The superiority of Jigsaw II and STAD as different from other cooperative learning strategies, stems from the fact that they are task structured (task specialization) and incentive structured (group rewards for individual learning, group reward for group product, and individual rewards) cooperative strategy in such a way that if well implemented will produce positive outcome. It was observed that Jigsaw II and STAD instructional strategies provides no room for free rider, in which some group members do all or most of the work while others go along for the ride (Slavin, 1995). Every member of the team must have learned the whole lesson in the home group, learn a portion in the Jigsaw group, then takes turn to teach the portion to his teammates, complete individual and group tasks (Moreno, 2009).

From the above findings, it can be deduced that Jigsaw II and STAD produced more positive effect on students' learning outcomes. They are therefore better approaches for teaching physics at senior secondary schools. Through the use of computer-supported Jigsaw II and STAD instructional content can be delivered in simplest, motivating, and peer-to-peer interactive manners.

On the interaction effect of gender on the academic performance of students in physics when taught using computer-supported Jigsaw II, STAD and TAI cooperative learning settings, and ICI no significant difference was established. These findings showed that gender had no influence on the performance of students in physics whether they were taught using computer-supported STAD or Jigsaw II or TAI cooperative settings or individualized computer instruction. These findings agree with the earlier findings of (Annetta, Mangrum, Holmes, Collazo & Cheng, 2009; Balfakih, 2003; Kniveton, 2006) that affirmed no gender difference between male and female students taught using JIGSAW II or STAD cooperative instructional strategy. However, it contradicts the finding of Fajola (2000) who reported that male students taught using STAD performed better than their female counterparts. It also contradicts the finding of Khairulanuar, Nazre, Sairabanu, and Norasikin (2010) where gender differences were established in favour of male students.

On the influence of academic ability levels on the academic performance of students in physics when taught using computer-supported STAD, Jigsaw II and TAI cooperative settings and individualized computer instruction setting, findings indicated significant difference for learners of different achievement levels exposed to computer-supported Jigsaw II, STAD and TAI cooperative settings, and ICI. It should be underscored that all the achievement levels had improved tremendously. These findings on academic ability levels agree with the earlier findings of Yager, Johnson, Johnson, (1985), that students' achievement levels (high, medium and low) actually influenced their performance. However, it contradicts the finding of Hampton and Grundnitski (1996) who found that low achiever benefited than others in cooperative learning. Furthermore, it contradicts the finding of Yusuf (2004) who revealed that achievement levels have no influence on academic performance of the learners taught using cooperative learning strategy.

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 in individualized setting. Furthermore, the findings provide sound empirical basis indicating that performance of students in physics and other science subjects would be greatly improved if students are exposed to varieties of computer-supported cooperative learning strategies.

5. Limitations of the Study

The following limitations can be observed regarding this study. First, in the implementation of the experimental study participants were not sampled using random sampling techniques, rather they were drawn from four purposively sampled senior secondary schools in Minna, Niger State. Thus, the findings may not be generalized to other federal and private institutions. Therefore, further studies would be needed before more meaningful generalizations based on the results of the study can be made. Second, the number of contents, lessons and weeks covered were limited, thus increase in the number of topics and weeks could have increased the acceptance of the outcome of the research. Third, computer use was limited to the presentation of curriculum contents only as students in the four groups were exposed to pre-test and post-test using paper and pencil approach. Despite these limitations the findings are significant, particularly in the use of computer-supported cooperative instructional strategy in the Nigerian school system.

6. Recommendations

Based on the major findings of this study the following recommendations are proffered. Teachers should expose physics students to computer-supported Jigsaw II and STAD cooperative instructional strategies so as to promote social interaction, active learning, discovery learning, motivation, learning by doing and learning by experience among students. In addition, Federal and State ministries of education and other educational agencies (NERDC, NTI, NUC, etc.), NGOs, UNICEF, UNESCO, and other education stakeholders should organize workshops on the use of computer-supported cooperative learning strategies to enhance better performance of secondary school students. Also, teacher education programme in Nigerian tertiary institutions should be improved upon to prepare teachers who can apply innovative approach (computer-supported instructional strategies), which will promote effective teaching and learning. Also, instructional designers, computer programmers, and instructional material developers should develop relevant computer assisted instructional packages for use within the Nigerian school systems.

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APPENDIX

OPERATIONAL GUIDE TO COMPUTER-SUPPORTED COOPERATIVE LEARNING PACKAGE

Similar instructional guide operates for the Individualized Computer Instruction (ICI) and Computer Cooperative-Supported Cooperative Groups (CSCG). The only difference is the way students interact with the computer. After the installation of Computer-Supported Cooperative Learning (CSCL) package into the computer system, the following steps are followed in operating the package:

(i) Boot the system, and click on ‘CSCL’ package icon on the desktop (Output: “Physics Computer-Supported Cooperative Learning Package” will be displayed.

(ii) Click on the “Individual or Group”: (Output: “Registration column” will appear) fig. 1

(iii) Register your Group Name (for group learners) or Your Name (for individual) Fig. 1

(iv) Click “Start Button” (Output: “Instructions will appear”) Fig. 2

(v) Click “Proceed Button” (Output: “Main menu will appear”) Fig. 3

(vi) Select any topic by clicking on the “Lesson Button” (Output: “contents of selected topic will appear”) Fig. 4

(vii) Click on the “Next Button” (Output: “Question(s) with plausible options A – D will come up”) Fig. 5

(viii) Students will continue the clicking on the NEXT Button to proceed and PREVIOUS Button to review the previous section of the lesson until the end of the lesson.

(ix) If the question is answered wrongly you will be taken back to the previous content and study it again.

(x) If you pick the wrong answer three times, the package will ‘log you OUT’ and terminates your activities. Then, you would have to call your instructor to log you ‘IN’ again. Fig. 6.

(xi) If all the questions are correctly answered, a ‘Congratulatory Message will appear, fig. 7.

(xii) The students will follow the above procedures until he/she masters the concepts 100% before going to the next topic.

RULES AND REGULATIONS GUIDING STUDENTS DURING CSCL ACTIVITIES

A. The Ten Commitments

1. I promise to do my share of work with pleasure and delight.
2. I will be brave to express myself in my group. My opinions do count.
3. I will be sensitive to my learning. If I find any problem or difficulty, I will turn to my teammates for help immediately.
4. When my classmates are doing their presentation, I will encourage them with my big smile and attentive eyes.
5. I am willing to help my classmates and teammates when they need me.
6. I will write “thank-you” note to one of my classmates and teammates after each class.
7. I will learn how to show my appreciation in words and in deeds to anyone who helps me during class discussion.
8. I will learn how to catch my classmates while they are doing something good.
9. I will respect the differences between my classmates and me.
10. I promise to enjoy every minute of our physics class by smiling happily all the time.

B. The Ten Commandments

1. I will not be late to turn in my homework.
2. I will not laugh at my teammates when they make mistakes.
3. I will not sleep in class.
4. I will not chat with teammates during group discussion.
5. I will not shout at my teammates when I am talking to them.

6. I will not take things from other teammates’ desk without permission.
7. I will not kick others’ feet under the table.
8. I will not eat or chewing gum or garlic when we have physics class.
9. I will not stay up late the night before physics class.
10. I will not swing my chair while seated.

NB: Students to will repeat their rules loudly before they started their physics class. The purpose of repeating all the rules and vows was for habit formation of self-control, discipline, and learner autonomy. When students got accustomed to this student-centered learning climate, the oral repetition of the rules could be omitted.