ENHANCING PHYSICS STUDENTS' RETENTION AND ATTITUDE USING COMPUTER -SUPPORTED TEAM ASSISTED INDIVIDUALIZATION STRATEGY

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Abstract

This study examined how computer-supported Team Assisted Individualization (TAI) cooperative learning as an instructional strategy for teaching physics would influence students' achievement, retention and attitude towards the subject. Five hypotheses were stated and tested at 0.05 level of significance. The design of the study was a 2x2x3 factorial, pre-test, post-test control group design. Purposive sampling technique was used to select two senior secondary schools in Minna Metropolis, Niger State, Nigeria. 97students from two intact classes from selected schools participated in the study. The students assigned to TAI and ICI groups. Computer-Assisted Learning Package (CALP) on physics, Physics Achievement Test (PAT), and Physics Attitude Scale (PAS) were used as treatment instrument, test instrument and Attitude scale respectively. Analysis of Covariance and Scheffe test were used for data analysis. Findings indicated that there was no significant difference in the academic performance of the groups. In addition, students' had positive attitude and better retention than their counterparts in individualized computer instruction. Based on the findings, it was recommended among others that teachers should use TAI strategy to arouse students' interest and promote their retentive memory.

Introduction

The poor performance of Nigerian students in physics at senior secondary school level has been attributed to poor attitude towards physics (Adegoke, 2010; Onadeko, 2009), perceived abstract and difficult nature of physics (Gambari, 2004; Okpala & Onocha, 1988), poor teaching and learning environment and lack of modern equipment (Adegoke, 2010; Kuti, 2006), poor mathematical ability of the students (Olatoye, 2007), and poor teaching method being adopted by many physics teachers (Adegoke, 2011, Gambari, 2010) and non-availability and utilization of instructional materials (Yusuf, Gambari & Olumorin, 2012). Some innovative 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); 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, 1999). The use of computer in ways that promote sequenced learning within groups can lead to in-depth processing of course content and, hence, more retention of

information (Yusuf, Gambari & Olumorin, 2012). How students communicate and behave around the computer also influences cooperative learning (Crook, 1999; Light & Littleton, 1999).

Cooperative learning is one of student-centered learning approach that has been documented in many literature as effective in helping students obtain practical learning skills, abilities for effective communication and proficiency in term of understanding knowledge, and it promotes positive student attitudes towards their own learning (Johnson & Johnson, 2008; Slavin, 2011). There are many quite different forms of co-operative learning strategies, but all of them involve having students work in small groups or teams to help one another learn academic material. In this study, Team Assisted Individualization (TAI) cooperative strategy was adopted.

Team Assisted Individualization (TAI) was specifically developed for teaching mathematics to students in grades 3-6 or older students. TAI combines co-operative learning with individualized instruction. However, in this study, TAI was adopted for teaching physics because mathematics shares many concepts and approach with physics. In TAI, students enter an individualized sequence according to a placement test and then proceed at their own rates. The team members work on physics units but teammates check each others' work against answer sheets and help one another with any problems. Final unit tests are taken without teammate help and are scored. Each week, teachers total the number of units completed by all team members and give certificates or other team rewards to teams that exceed a criterion score based on the number of final tests passed, with extra points for perfect papers and completed homework (Slavin, 1983). This strategy enables students to encourage one another's learning and feel responsible for helping each other for the sake of the group product. When confronted with a complex task, the TAI strategy enable students use task skills and teamwork skills in order to work together to solve the problem (Johnson, Johnson, & Johnson-Holubec, 1993)

Several large evaluations of TAI have shown positive effects on mathematics achievement in the upper-elementary grades (Slavin & Karweit, 1985; Stevens and Slavin, 1995). Oishi, Slavin, and Madden (1983) found positive effects of TAI on cross-racial nominations on two sociometric scales. In a similar study, Oishi (1983) found significantly positive effects of TAI on cross-racial ratings of smart and on reductions in ratings of not nice. Slavin, Leavy, and Madden (1984) used teacher ratings of students' classroom behaviour and found significant higher ratings for TAI students. Artut and Tarim (2007) too found positive effects of TAI on Mathematics achievement and retention. Gupta & Pasrija (2011) also found supremacy of co-operative learning method (TAI) over traditional method of teaching. In another study, Xin (1996) found an improvement in mathematics achievement and students developed more positive attitudes toward math when taught with computer-assisted TAI cooperative learning approach. However, Yusuf, Gambari and Olumorin (2012) did not find any statistical difference between students exposed to computer-supported TAI and those taught using individualized computer instruction.

However, Tarim and Akdeniz (2008) found no significant difference in students' academic achievement and attitudes towards mathematics when exposed to Team Assisted Individualization (TAI) and Student Teams-Achievement Divisions (STAD). Similarly, Karper and Melnick (1993) found no significant differences between students taught Mathematics using TAI and those taught with conventional method. Similarly, Slavin and Karweit (1984c) 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.

According to Adegoke (2011) students performed better when they develop positive attitude towards a course. For instance, Salend and Washin (1988) reported that TAI increased the students' on-task and cooperative behaviors, increased the students' liking of their classmates when compared to working independently. Similarly, Slavin (1984a) found that TAI approach had positive effects on mathematics achievement, behavioral ratings, and student attitudes. Slavin (1984b) found that TAI improved social and academic behavior, and increased mathematics achievement more than traditional methods. However, Rosini and Jim (1997) reported no significant difference in the achievement, retention and attitude of those taught home economics using cooperative learning strategy and those taught with traditional method.

The instructional values of cooperative strategies had been established in developed nations three centuries ago, however, the extent of the effects of these strategies on Nigerian students' performance in physics is yet to be fully explored. Also, researches on the effects of computer-assisted TAI cooperative strategy in Nigeria are yet to be discovered. Adoption of TAI for teaching physics concepts is a novel idea. Furthermore, comparative studies on the effects of computer-assisted TAI cooperative learning and individualized computer instructional are very scanty. In view of this, the present study examined the effect of computer-supported TAI cooperative learning strategy on students' performance in physics.

Research Hypotheses

The following null hypotheses were tested in the study.

(i). There is no significant difference in the achievement of students exposed to physics using computer-supported TAI cooperative setting and individualized computer instruction (ICI).

(ii). There is no significant difference in the retention of students exposed to physics using computer-supported TAI cooperative setting and individualized computer instruction (ICI).

(iii). There is no significant difference in the attitude of students exposed to physics using computer-supported TAI cooperative setting and individualized computer instruction (ICI).

Methodology

In this research, an experimental study was undertaken using the Pre-test-Post-test Non-equivalent, non-randomized group design, to test the cause and effect relationship between a treatment variable (computer-supported TAI) and the outcome variable (achievement in physics). Two instructional strategies comprised of computer-supported TAI and individualized computer instruction groups) were the independent variable while gender (male and female) and ability (high, medium & low) are the moderating variables.

In selecting the participated schools, purposive random sampling was used to select two secondary schools in Minna, Niger State, Nigeria. These schools were selected based on (i) equivalence in terms of laboratories, facilities and manpower; (ii) school ownership (public schools); (iii) gender composition (mixed schools); (iv) ICT facilities in terms of computer laboratories, functional computers and standby generators; (vi) candidates' enrolment that is, Senior Secondary School Certificate in Education in physics for a minimum of ten years). In selecting and assigning the group, intact class in each of the two schools were selected and randomly assigned to experimental (computer-supported TAI) and control (ICI) groups using simple random sampling technique.

Seventy nine (79) students participated in the study, 41 students were in TAI cooperative learning strategy (Exp. Group 1), and 38 students in ICI strategy, the control group. They were stratified into gender (male & female). Three research instruments were employed in this study:

(i). Treatment Instrument: (Computer Assisted Learning Package (CALP) for senior secondary physics 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. The package was validated by computer programmers and educational technology experts; subject content (physics) specialists; and finally field tested (students validation) on sample representative similar to the students used for the final 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. The main difference between the group-based programme and the individualised programme were 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 West African Examination Council (WAEC, May/June, 1988-2010) and National Examination Council (NECO, June/July, 2000-2007). The Test (PAT) was based on the contents of the CALP package. Each of the stems of the PAT had five options (A - D) as possible answers to the question. Students were required to indicate their correct answers by ticking one of the letters (A - D) that corresponds to the correct option in each item. This instrument (PAT) was administered to the experimental and control groups as pre-test, post-test and retention test after it had been reshuffled. The items were validated and tested for reliability using 40 randomly selected SSII students. A reliability coefficient of 0.90 was obtained using Kuder Richardson (KR-21).

(iii) Physics Attitude Scale (PAS): The PAS instrument used for this research was developed by the researchers to measure the students' attitude towards physics before and after exposed to computer-supported TAI cooperative learning strategy. It contained two sections. Section A included four questions and it focused on demographic information of physics student: school and gender. Section B focused on students' attitude towards physics subject. The section contained 20- item four point response mode of Strongly Agree (coded 4), Agree (coded 3), Disagree (coded 2) and Strongly Disagree (coded 1) was used. To test the instrument's validity and reliability, the initial draft of 25-item of PAS was validated by experts. Also, it was administered on students drawn from a school outside the sampled schools. The feedback obtained from this first administration was used to modify the final copy of the instrument. The final instrument of 20-item questionnaire was tested for reliability using test-retest method of three weeks interval. The reliability coefficient of 0.86 was obtained using Pearson Product Moment Correlation Coefficient. 84 copies of the questionnaire were distributed to physics students before and after the commencement of experiment. Eighty four copies were returned at a return and usable rate of 100%.

In collecting the data for this study, 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: use of CAI in instruction, elements of cooperative learning, roles of teachers in cooperative

settings, using computer-supported cooperative learning strategy; and encouraging students' participation in the use of the computer for learning the concepts. 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 individualised computer instruction using the CALP package.

Students were exposed to four weeks training on cooperative learning skills which include: principles of cooperative learning; social skills; conflicts resolution; roles and responsibilities sharing; rules and regulations (e,g ten commitments & ten commandments. Then, students in the experimental groups were heterogeneously divided into groups with three members each, composed of students of different gender and different academic achievement levels. To avoid bias in grouping, various grouping techniques were employed in each schools, these include: team portrait, team vision statement, classmate scavenger hunt, and card sort team building structure and many others. 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 students in the sampled schools as pre-test. The CALP package was installed on standalone computer systems. 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 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 two 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-assisted cooperative learning strategy (TAI) as treatment, while the control group students were individually exposed to the computer assisted instructional package. Immediately after the treatment, PAT was administered as post-test.

Specific group based activities for experimental group (Team Assisted Instruction) include: (i) Students were placed on standalone computer on individualised bases, and then each student proceeded at his/her pace; (ii) Members study the same concept independently but; (iii) Teammates sought for assistance from teammates and checked each other's work using worksheets to help one another to solve problems; (iv) Group member meet and submit a completed tasks in which teammate have the same scores; (v) 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, and finds the average and give certificates or other team rewards based on laid down criterion. This was done on weekly basis for the period of six weeks

In the control group (Individualized Computer Instruction), 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 without the help of his colleagues.

Data obtained from PAT and PAS at pretest and posttest were analysed using Analysis of Covariance (ANCOVA) and Scheffe's test using Statistical Package for Social Sciences (SPSS) version 11 at 0.05 alpha level.

Results

The results are presented based on the research hypotheses:

Hypothesis One: There is no significant difference in the achievement of students exposed to physics using computer-supported TAI cooperative setting and individualized computer instruction (ICI).

To determine whether there was significant difference in the posttest mean scores of the experimental (computer-supported TAI) and control groups (ICI), data were analyzed using the analysis of covariance (ANCOVA). Table 1 contains the result of the analysis.

Table 1: ANCOVA post-test on experimental (TAI) and control (ICI) groups

Source of Variation	Sum of Square	df	Mean Square	F	Significance of F
Covariate (Pre-test)	1756.980	1	1756.980	46.202	0.000
Main Effect (Treatment)	1.056	1	1.056	0.028	0.868
Model	1792.232	2	896.116	23.564	0.000
Residual	2890.148	76	38.028		
Total	309227.000	79			

Table 1 shows that an $F(1, 76) = 0.028$, $p > 0.868$ for the main effect (treatment) was not significant, this indicates that the method of instruction did not produced any significant effect on the post-test achievement scores of students when covariate effect (pretest) was controlled. The result indicates no significant difference between the achievement of those in TAI and ICI groups.

The achievement of students in both groups were further compared based on the mean gain scores between the pretest and posttest for each group and the results are shown in Table 2 and graphically illustrated in Figure 1.

Table 2: Mean Gain Scores of Students exposed to TAI and ICI

Group	Pretest	Posttest	Mean Gain Score
TAI	21.05	62.73	41.68
ICI	19.82	61.39	41.57

Table 2 shows that both groups had improved performance in posttest. For instance, TAI had the mean gain scores of 41.68 while ICI had the mean gain scores of 41.57. This indicates that both groups benefited from the treatment, with TAI having slight higher achievement.

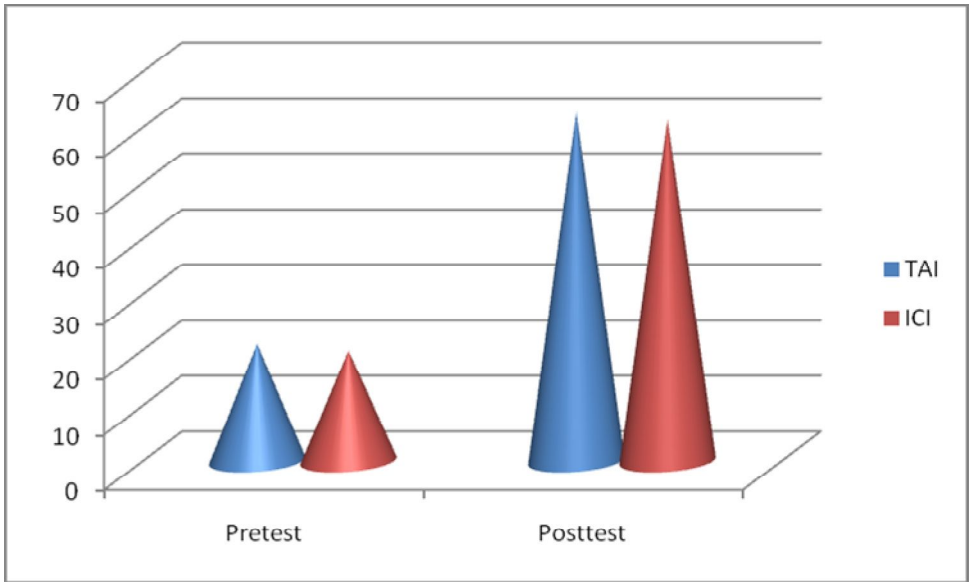

Fig. 1: Graphical illustration of students exposed to TAI and ICI

Hypothesis Two: There is no significant difference in the retention of students exposed to physics using computer-supported TAI cooperative setting and individualized computer instruction (ICI).

To determine whether there was significant difference in the posttest mean scores of the experimental group (computer-supported TAI) and control group (ICI), data were analyzed using the analysis of covariance (ANCOVA). The results of the analysis are shown in Table 3.

Table 3: ANCOVA retention on experimental (TAI) and control (ICI) groups

Source of Variation	Sum of Square	df	Mean Square	F	Significance of F
Covariate (Pretest)	1666.054	1	1666.054	43.202	0.000
Main Effect (Retention)	0.410	1	0.410	0.011	0.918
Model	1695.414	2	847.707	21.982	0.000
Residual	2930.889	76	38.564		
Total	263926.000	79			

Table 3 indicates that, the main effect of treatment group (computer-supported TAI) and ICI groups produced an F (1,76) = 0.011, p = 0.918. This result was not significant at 0.05 alpha level. This shows that, there was no significant difference in retention of students taught physics using computer-supported TAI. Hypothesis two is therefore not rejected. This signifies that students in computer-supported TAI group did not significantly better than those in ICI group.

The mean gain scores between the pretest and posttest retention of computer-supported TAI and ICI groups were tabulated and graphically illustrated as shown in Table 4 and Figure 3 respectively.

Table 4: Mean Gain Scores of Students' retention in TAI and ICI groups

Group	Pretest	Posttest	Mean Score	Gain
TAI	21.05	57.88	36.83	
ICI	19.82	56.66	36.84	

Table 4 shows that, both TAI and ICI had high retention from the treatment. The students in computer-supported TAI group had higher mean gain scores of 36.83 while those in ICI group had mean gain scores of 36.84. This indicates that both groups benefited from the treatment and retained more physics concepts after four weeks of treatment. Furthermore, the comparison in the mean scores between their pretest and posttest is shown in Figure 2.

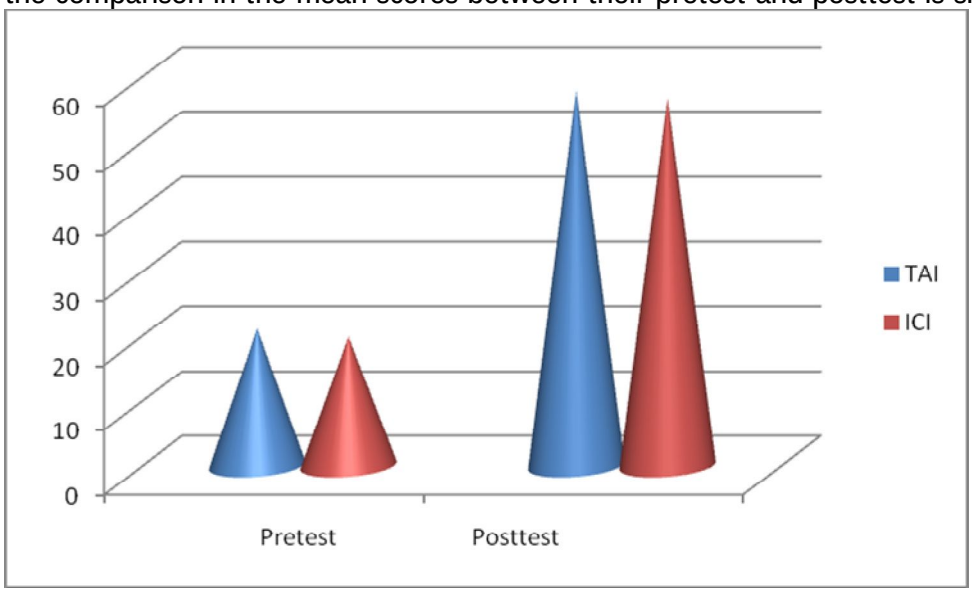

Fig. 2: Graphical illustration of students retention in TAI and ICI

Hypothesis Three: There is no significant difference in the attitude of students exposed to physics using computer-supported TAI cooperative setting and individualized computer instruction (ICI).

To determine whether there was significant difference in the posttest mean scores of the experimental (computer-supported TAI) and the control groups (ICI), data were analyzed using the analysis of covariance (ANCOVA). The results on this hypothesis are as shown in Table 5.

Table 5: ANCOVA post-attitude on experimental (TAI) and control (ICI) groups

Source of Variation	Sum of Square	df	Mean Square	F	Significance of F
Covariate (Pretest)	25.760	1	25.760	0.482	0.528
Main Effect (Attitude)	1850.864	1	1850.864	28.852	0.000
Model	1852.883	2	926.442	14.442	0.000
Residual	4875.405	76	64.150		
Total	280949.040	79			

The analysis in Table 5 shows that, the main effect of treatment group (computer-supported TAI) on attitude produced an F (1, 76) = 28.852, p = 0.000. This result was significant at 0.05 alpha level. This hypothesis three is therefore rejected. This indicates that attitudes of students in TAI group differ significantly from that of their counterparts in ICI.

The mean gain scores between the attitude of students in TAI and ICI groups were tabulated and graphically illustrated in Table 6 and Figure 3 respectively.

Table 6: Mean gain scores of attitude in computer-supported TAI

Group	Pretest	Posttest	Mean Gain Score
TAI	33.540	63.55	30.01
ICI	35.253	53.92	16.67

Table 6 shows that attitude of students in TAI and ICI groups differed significantly. The attitude of students in TAI group had higher mean gain scores of 1.50 while the attitude of students in ICI had mean gain scores of 0. 81. This indicated that students in TAI had better attitude towards physics than those in ICI group. Furthermore, the comparison of the mean scores between their pretest and posttest is shown in Figure 2.

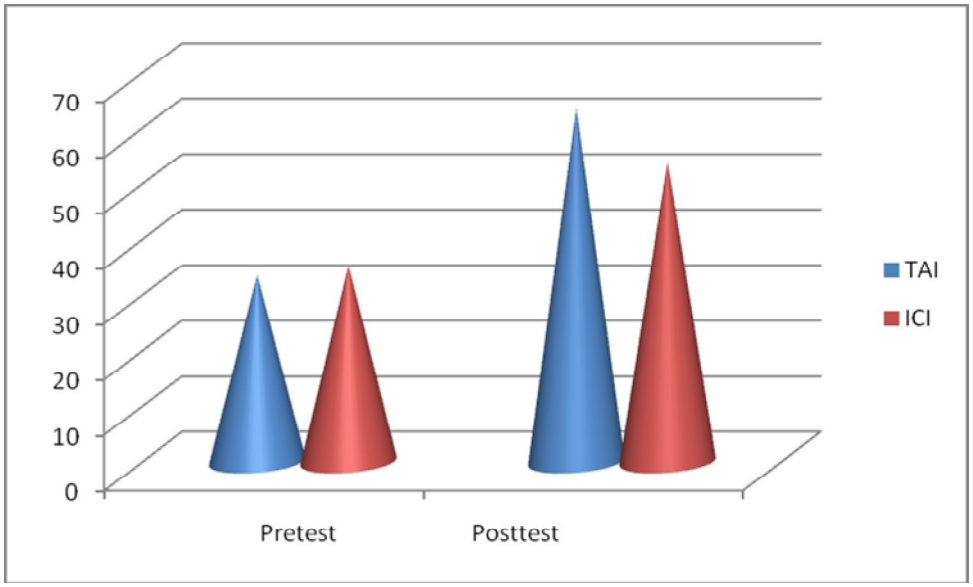

Fig. 3: Graphical illustration of attitude of students exposed to TAI and ICI

Discussion of Findings

The results of the analyses related to the hypothesis one indicated no significant difference in the performance of students taught physics using computer-supported TAI and those taught with ICI. The findings agree with earlier findings of Karper and Melnick (1993) and Slavin and Karweit (1984c) found no significant differences between students taught Mathematics using TAI and those taught with conventional method and individualized instruction groups respectively. However, the findings of this study did not support the findings of Slavin and Karweit (1985); Stevens, Slavin (1995), Oishi, Slavin, and Madden (1983); Oishi (1983), Slavin, Leavy, and Madden (1984) and Gupta & Pasrija (2011) which found supremacy of co-operative learning method (TAI) over traditional method of teaching. Furthermore, it agree with finding of Xin (1996) which found an improvement in mathematics achievement and students developed more positive attitudes toward math when taught with computer-assisted TAI cooperative learning approach.

The finding of this study may be attributed to lack of adequate interaction between those in computer-supported TAI cooperative setting. Students sitting one on one to computer may affect their level of interaction unlike when sitting together in a group sharing one computer. TAI was specifically designed for mathematics instruction but adopted in this study for physics instruction this might have responsible for negative outcome obtained. In addition, lack of proper implementation of the TAI strategy may contribute to negative outcome. For instance, in a study (Nath & Ross, 1996) of teachers using Student Teams-Achievement Divisions (STAD) found that if teachers did not strictly adhere to the framework of cooperative learning, the method was unsuccessful and students spent more time on disagreements or conflict management than they did on academic tasks.

On the influence of attitude towards students performance when taught physics using computer-supported TAI cooperative learning and those taught using ICI. The findings agree with findings of Salend and Washin (1988), Slavin (1984a). Slavin (1984b) and Chunamthiang (1998) found that TAI method enhanced students' learning behaviors in mathematics than conventional teaching method. However, it contradicts with the earlier findings of Tarim and Akdeniz (2008) found no significant difference in students' academic achievement and attitudes towards mathematics when exposed to Team Assisted Individualization (TAI) and Student Teams-Achievement Divisions (STAD).

The results of the analyses related to the hypothesis three indicated no significant difference between the performance of students taught using computer-supported TAI and those taught with ICI on retention test. The findings agree with findings of The finding agree with the earlier findings of Artut and Tarim (2007) which found positive effects of TAI on Mathematics achievement and retention. However, it contradicts the finding of Rosini and Jim (1997) which reported no significant difference in the achievement, retention and attitude of those taught home economics using cooperative learning strategy and those taught with traditional method.

Conclusion

The paper has examined the factors responsible for poor performance in physics at senior secondary schools in Nigeria and how innovative teaching strategies can be used to overcome the problem. It is the view of the authors that there is still a wide gap to be bridged in the area of teaching and learning. The innovative technology using computer-assisted TAI seems to be the answer especially to low achievers. Computer-Assisted Team Assisted Individualization was not found effective in teaching physics in this study, but was more effective in teaching mathematical concept and is also gender friendly.

Recommendation

Based on the findings of this study, it is recommended that teachers should be encouraged to use computer-supported TAI cooperative learning to stimulate learners' interest, motivate them and change their attitude towards the subject. TAI cooperative learning strategy should be used to promote retention among physics students.

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