IMPROVING LEARNING OPPORTUNITIES FOR NIGERIAN LOW ACHIEVERS IN PHYSICS THROUGH COMPUTER SUPPORTED TEAM ASSISTED INDIVIDUALIZATION

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Abstract

This study examined the computer-supported Team Assisted Individualization (TAI) cooperative learning as an instructional strategy for teaching physics on its effects on students' achievement, gender and achievement levels. 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. Seventy nine participants from two intact classes from selected schools were assigned into experimental (TAI) and control (ICI) groups. Computer-Assisted Learning Package (CALP) and Physics Achievement Test (PAT), were used as treatment instrument and test instrument respectively. Analysis of Covariance and Scheffe' post-hoc test were used for data analysis. Findings indicated that there was no significant difference in the academic performance of the groups. In addition, students' gender had no influence on their performance; however, TAI favour low achievers than high achievers in academic performance. Based on the findings, it was recommended among others that teachers should use TAI strategy to encourage low achievers to participate in the classroom activities.

Keywords: Computer, Achievement Level, Gender, Achievement, TAI, Physics

Introduction

Educators use cooperative learning as a teaching method in all grade levels, in all curriculum areas, and for many different purposes, but all uses center around the goal of getting students to understand and learn the material presented. Cooperative learning allows students to communicate their ideas with each other, brainstorm responses, and work to solve problems together. The importance of students becoming more involved with the learning process has been emphasized and needs to be implemented in classrooms around the globe (Slavin, 2009, Yusuf, Gambari & Olumorin (2012)).

Researchers recognized that students learn better when collaborating with each other (Ige, 2004; Yusuf, 2004; Webb, Franke, Ing, Chan, De, Freund, & Battey, 2008). If this style of learning is so widely recognized, accepted, and expected, then teachers need to know how to incorporate the best techniques for this strategy into their teaching, especially at the secondary school level where poor performance in physics was predominant.

The percentage of students that passed physics at credit level and above (A1-C6) was consistently less than 50% for the past 8 years (2006-2013) in Nigeria (WAEC, 2013). The causes of poor performance can be attributed to poor teaching methods employed by

physics teachers, non-availability and utilization of computer technology in the schools, and many others (Ajaja, 2002; Jegede, 2007; Gambari, 2010; Yusuf & Afolabi, 2010). The use of computer to support cooperative learning could provide solution to students' poor performance in physics.

The potential benefits of Computer Assisted Instruction (CAI) cannot be underestimated in the contemporary world. There is a plethora of established findings on the instructional value of computer, particularly in advanced countries. There are now several CAI packages on different subjects. It is obvious that the current trend in research all over the world is the use of computer facilities and resources to enhance students' learning (Yusuf & Afolabi, 2010). The computer is a medium through which groups can communicate their understanding and provides a way to represent and store shared knowledge (Reyna, Branerd, Effken, Bootzih, & Lloyd, 2001; Sherman, 2001). Small groups interacting around and through the computer promotes productive cooperative learning (Fajola, 2000; Gambari, 2010).

There are many cooperative teaching strategies in existence but the basic characteristics and components of cooperative teaching do not change in those strategies. (Alebiosu, 2003; Joliffe, 2005; Sarah & Cassady, 2006), Team Assisted Individualization (TAI) cooperative strategy is one of those that received the most prominent attention.

TAI combines cooperative learning with individualized instruction. TAI is specifically designed to teach mathematics to students in grades 3-6 or older students not ready for a full algebra course. In this study, it was adopted to teach physics since knowledge of mathematics can influence students' performance in physics. In TAI, students enter an individualized sequence according to a placement test and then proceed at their own rates. In general, team members work on the same units. Team-mates 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 by student monitors. 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, 2009).

The effects of Team Assisted Individualization (TAI) cooperative learning strategy on students learning is has not established. There is conflicting reports regarding the effect of TAI on student achievement and attainment. There are some evidences that the use of TAI cooperative learning strategy can increase student achievement. For example, Artut & Tarim (2007), Gupta and Pasrija (2011) reported the supremacy of TAI cooperative learning strategy over traditional method of teaching. 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).

Gender has been identified as one of the factors influencing students' performance in sciences at senior secondary school level. Olson (2002) reported gender related differences in the performance of students taught mathematics using cooperative learning, as individual course grades were higher for females than males. However, Adeyemi (2008), Kost, Pollock and Finkelstein (2009) and Khairulanuar, Nazre, Sairabanu, and Norasikin, (2010) reported that gender had no effect on academic performance of students.

Learners' achievement levels and academic performance has attracted the attention of researchers. Fajola (2000), Aluko (2004), Ige (2004) found that high and medium achievers were favoured than low achievers in cooperative learning. However, Yusuf (2004) revealed that achievement levels had no influence on academic performance of the learners.

Cooperative learning encourages students to be active participants in the construction of their own knowledge. It also encourages students to interact and to communicate with peers in harmony. In this way, cooperative learning promotes values such as honesty, cooperation, mutual respect, responsibility, tolerance, and willing to sacrifice a

consensus (Zakariya et al, 2013). Therefore, to enhance the understanding of physics, students must be more active in the classroom and must creatively acquire knowledge, especially in understanding and solving physics problems.

Based on the reviewed literature, the extent of the effects of computer-supported TAI settings on Nigerian students' performance in physics is yet to be fully explored. Studies on computer-supported TAI cooperative learning strategy against individualized computer instruction are not common. 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 performance of secondary school students taught physics using computer-supported TAI cooperative settings and individualized computer instruction.

(ii). There is no significant difference in the performance of male and female students taught physics using computer-supported TAI cooperative settings.

(iii). There is no significant difference in the performance of high, medium and low achievement level students taught physics using computer-supported TAI cooperative setting.

Methodology

The research design adopted for this study is a quasi-experimental design. It is a pretest, posttest, non-equivalent, non-randomized control group. Two levels of independent primary variable (one treatment and a control), two levels of gender (male and female) and three levels of academic achievement (high, medium, and low).

In selecting the schools, purposive random sampling was used to select two secondary schools in Minna, Niger State, Nigeria. These schools were sampled based on facilities (Laboratories and manpower), school type (public schools), gender composition (co-educational schools). The two schools were randomly assigned to experimental group (computer-supported TAI group) and control group (individualized computer instruction, ICI)) respectively.

Seventy nine students participated in the study, 41 students were assigned to the TAI cooperative learning strategy (Exp. Group 1), and 38 students in ICI strategy, the control group. They were stratified into gender (45 male & 34 female), and academic levels (25 high, 30 medium and 24 low) based on their performance in the last promotion examination in physics. The distribution of the sample is as shown in Table 1.

Table 1: Distribution of sample for the study

Groups	Gender		Achievement Levels		
	Male	Female	High	Medium	Low
TAI	24	17	13	14	14
ICI	21	17	12	16	10

Two research instruments were employed in this study (treatment and test instruments):

(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 four computer programmers and four educational technology experts; four subject content (physics) specialists; and finally field tested (students validation) on 20 sample representative similar to the students used for the final study. The package contained 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-developed Physics Achievement Test (PAT). The PAT consists of 100 multiple choice objective items adopted from past examination of West African Examination Council (WAEC, May/June, 1988-2010) and National Examinations Council (NECO, June/July, 2000-2007). The PAT was based on the contents of the CALP package. Each of the stems of the PAT had five options (A-E) as possible answers to the question. Students were required to indicate their 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 as posttest after it had been reshuffled. The items were validated and tested for reliability using 40 randomly selected SSII students. The test was administered once on the pilot samples. A reliability test using the Kuder-Richardson (KR-21) revealed a reliability coefficient of 0.90 which was considered adequate for the research study.

In collecting the data for this study, the researcher visited the selected schools and sought for 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 strategy. 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. Teachers in the experimental group received specific training designed to equip them with the necessary strategies for implementing treatment, such as: 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 teachers in the control group were 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 ability 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-supported cooperative learning strategy (TAI) as treatment, while the control group students were individually exposed to the individualized computer 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 team-mates and checked one another's work using worksheets to help in solving problems; (iv) Group members meet and submit a completed tasks in which team-mate have the same scores; (v) Final unit test was taken without help from group members and scored by the teachers; (vi) 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 control group (Individualized Computer Instruction), students in this group were taught the concepts of physics 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 their colleagues.

Data obtained from PAT and PAS at pre-test and post-test were analysed using Analysis of Covariance (ANCOVA) and Scheffe's test using Statistical Package for Social Sciences (SPSS) version 13 at 0.05 alpha level, with the pre-test serving as the covariate.

Results

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 TAI cooperative setting and individualized computer instructional (ICI) method.

To determine whether there was significant difference in the post-test mean scores of the experimental (computer-supported TAI) and control groups (ICI), data were analyzed using the analysis of covariance (ANCOVA). Table 2 contains the result of the analysis.

Table 2: ANCOVA posttest on experimental (TAI) and control (ICI) groups

Source of Variation	Sum of Square	df	Mean Square	F-value	P-value
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 2 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 a significant effect on the post-test achievement scores of students when covariate effect (pre-test) was controlled. The result indicates that there was no significant difference between students exposed to TAI and those exposed to ICI.

The performance of students in the two groups was further compared and the results are shown in Table 3 and graphically illustrated in Figure 1.

Table 3: Mean Gain Scores of Students Taught Physics Using TAI and ICI

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

Table 3 shows that, the groups had improved performance in post-test. For instance, TAI had the mean gain scores of 41.68 while ICI had the mean gain scores of 41.57. This indicates that all the groups benefited from the treatment. Therefore, there is no significant difference between the mean achievement scores of students in experimental group (TAI) and those in control group (ICI).

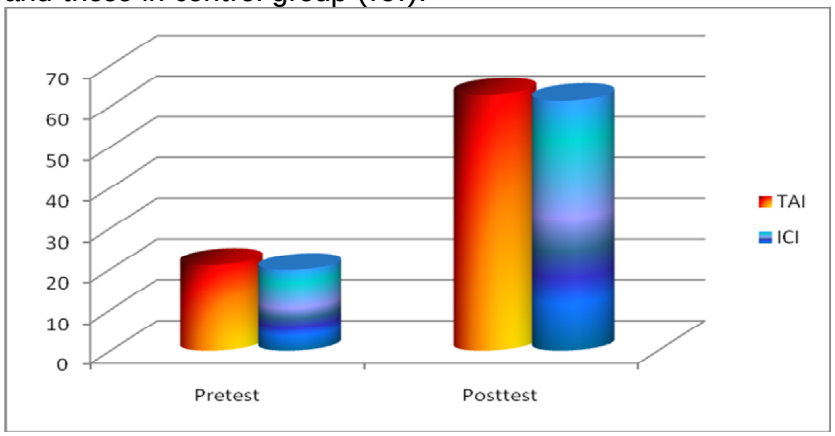

Fig. 1: Graphical illustration of students exposed to TAI and ICI

Hypothesis Two: There is no significant difference between the performance of male and female students taught physics using computer-supported TAI cooperative setting.

To determine whether there was significant difference in the post-test mean scores of male and female students using computer-supported TAI, data were analyzed using the analysis of covariance (ANCOVA). The results of the analysis are shown in Table 4.

Table 4: ANCOVA posttest on male and female students in TAI group

Source of Variation	Sum of Square	df	Mean Square	F-value	P-value
Covariate (Pretest)	1447.002	1	1447.002	74.027	0.000
Main Effect (Gender)	0.012	1	0.012	0.001	0.980
Model	1447.262	2	723.631	37.020	0.000
Residual	742.786	38	19.547		
Total	2190.049	40			

Table 4 shows that, main effect of treatment group (computer-supported TAI) on gender produced an F (1, 38) = 0.001, p = 0.980. This result was not significant at 0.05 alpha level. This indicates no significant difference in the performance of male and female students exposed to computer-supported TAI. The hypothesis two is therefore not rejected. This implies that male students' achievement did not differ significantly from that of female students when both were taught using computer-supported TAI.

The mean gain scores between the pretest and posttest among male and female in the computer-supported TAI group were tabulated and graphically illustrated as shown in Table 5 and Figure 2 respectively.

Table 5: Mean Gain Scores of Male and Female in Computer-Supported TAI group

Group	Pretest	Posttest	Mean Gain Score
Male	20.95	62.65	41.70
Female	21.14	62.81	41.67

Table 5 shows that male students had higher mean gain scores of 41.70 while the female students had mean gain scores of 41.67. This indicates that both groups benefited from the treatment. Therefore, there is no significant difference between the mean achievement scores of male and female students. Furthermore, the comparison in the mean scores between their pretest and posttest is shown in Figure 2.

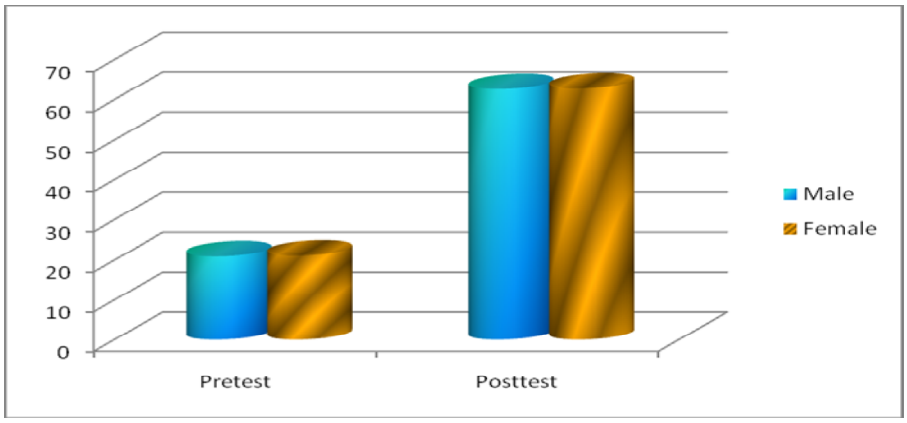

Fig. 2: Graphical illustration of male and female students exposed to TAI

Hypothesis Three: There is no significant difference in the performance of high, medium and low achiever students taught physics using computer-supported TAI cooperative setting.

To determine whether there was significant difference in the post-test mean scores of the computer-supported TAI, data were analyzed using the analysis of covariance (ANCOVA). Table 6 shows analysis of the result.

Table 6: ANCOVA posttest on high, medium and low achievers in TAI group

Source of Variation	Sum of Square	df	Mean Square	F-value	P-value
Covariate (Pretest)	364.669	1	364.669	19.138	0.000
Main Effect (Level)	37.784	2	18.892	0.991	0.381
Model	1485.034	3	495.011	25.979	0.000
Residual	705.015	37	19.054		
Total	163536.000	41			

Table 6 indicated that an F (1, 37) = 0.991, p = 0.381 for the main effect was significant at 0.05 alpha level. This indicates that there was no significant differences in the posttest mean scores of the high, medium and low achiever students. This implies that the use of computer-supported TAI was influenced by the achievement levels as the initial advantage at the pretest had been statistically controlled using ANCOVA.

A post-hoc analysis using Scheffe test was conducted to determine the direction of difference among the three achievement levels. The result of the analysis is shown in Table 7.

Table 7: Scheffe's post-hoc analyses of the groups mean scores

Groups	Mean Scores	Group I (High)	Group II (Medium)	Group III (Low)
Group I (High)	71.13		*0.020	*0.000
Group II (Medium)	64.38	*0.020		*0.002
Group III (Low)	57.24	*0.000	*0.002	

* The mean difference is significant at the 0.05 level.

The data in Table 4 indicates significant difference in the posttest mean scores of high achievers ($\overline{X}$ = 71.13) and medium achievers ($\overline{X}$ = 64.38) in favour of high achievers. It also indicates significant difference in the posttest scores between medium achievers ($\overline{X}$ = 64.38) and low achievers ($\overline{X}$ = 57.24) in favour of medium achievers. Significant differences was established in the posttest mean scores between high achievers ($\overline{X}$ = 71.13) and low achievers ($\overline{X}$ = 57.24) in favour of high achievers.

Table 8: Mean Gain Scores of high, medium and low achievers in TAI group

Group	Pretest	Posttest	Mean Gain Score
High	28.13	71.13	42.87
Medium	22.81	64.38	41.57
Low	16.06	57.24	41.18

Table 8 shows that high, medium and low achievers benefited from the treatment. However, there was difference in the mean gain scores of different achievers exposed to computer-supported TAI setting. The high achievers had 42.87 mean gain scores, followed by medium achievers with mean gain scores of 41.57 and low achievers with 41.18 as mean gain scores. This implies that all the groups benefited from the treatment. Therefore, no significant difference was established among the three groups (high, medium and low). The mean gain scores of the three achievement levels are further shown in Figure 3.

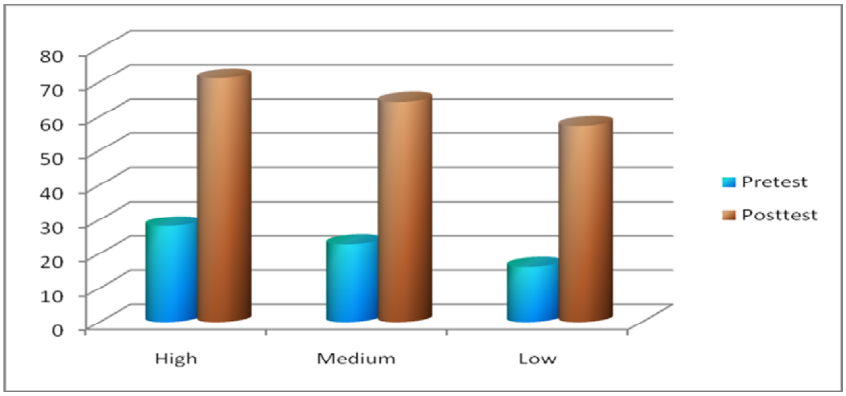

Fig. 3: Graphical illustration of high, medium and low achievers exposed to TAI

Hypothesis Four: There are no interaction effects of gender and achievement levels on the performance of students taught physics in computer-supported cooperative setting.
The results on this hypothesis are shown in Table 9.

Table 9: Interaction Effects of Treatment, Gender, and Achievement Levels

Source of Variation	Sum of Square	df	Mean Square	F-value	P-value
Post-test covariates pre-test	1756.980	1	1756.980	46.202	0.000
Main effects (combined)					
Treatment	277.670	1	277.670	9.142	0.004
Gender	58.107	1	58.107	1.913	0.171
Levels	1757.321	2	878.661	28.928	0.000
2-way interactions (Combined)					
Treatment*Gender	98.004	1	98.004	3.227	0.077
Treatment*Level	47.342	2	23.671	0.779	0.463
Gender*Level	234.441	2	117.220	3.859	0.026
3-way interactions					
Treatment*Gender*Level	152.713	2	76.356	2.514	0.089
Model	2647.286	11	240.662	7.923	0.000
Residual	2035.094	67	30.375		
Total	309227.000	79			

Table 9 shows significant main effect of the treatment F (1, 67) = 9.142, p = 0.004 at 0.05 alpha level. The analysis also revealed significant interaction effect of achievement levels F (1, 67) = 1.913, p = 0.171. However, gender F (1, 67) = 28.928, p = 0.000 had no interaction effect on students' performance. In other words, treatment had effect on the students' performance. The analysis further showed significant 2-way interaction effect on students' performance in physics based on treatment and gender, F (1, 67) = 98.004, p = 0.077; and gender and achievement levels, F (2, 67) = 3.859, p = 0.026. However, there was no significant 2-way interaction effect was established for treatment and achievement levels, F (2, 67) = 0.779, p = 0.463. The analysis revealed further that there was significant 3-way interaction effects of treatment, gender and achievement levels, F (2, 67) = 2.514, p = 0.089 of students. This implies that there was significant joint interaction effect of the independent variables (treatment, gender and achievement level) on the dependent variable (performance of the students).

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 Artut & Tarim (2007), Gupta and Pasrija (2011) who reported the supremacy of TAI cooperative learning strategy over traditional method of teaching. However, the findings of this study did not support the finding of Tarim and Akdeniz (2008) who 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 finding of this study may be attributed to lack of adequate interaction between those in computer-supported TAI cooperative learning group. Students sitting one on one to computer may affect their level of interaction unlike when sitting together in a group sharing one computer. In addition, lack of strictly adherence to the framework of cooperative learning strategy may led to its failure because students spent more time on disagreements or conflict management than they did on academic tasks (Nath & Ross 1996).

On the influence of gender on academic performance of students in physics when taught using computer-supported TAI cooperative setting, findings indicated no significant difference in the performance of male and female students. This finding agree with findings

of Adeyemi (2008), Kost, Pollock and Finkelstein (2009) and Gambari (2010) which reported that gender had no influence on academic performance of students taught with cooperative learning. However, it also contradicts the finding of Khairulanuar, Nazre, Sairabanu, and Norasikin (2010) where gender differences were established in favour of male students. It also differs from the findings of Olson (2002) which found that females performed better than males in cooperative learning.

On the influence of on achievement level on students' academic performance in physics when taught using computer-supported TAI cooperative setting, the findings agree with the finding of Yusuf (2004) who reported that achievement levels had no influence on academic performance of the learners. However, it contradicts the findings of Fajola (2000), Aluko (2004) and Ige (2004) who reported significant difference in favour of high, medium and low respectively.

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 computer-supported TAI seems to help improved low achievers performed in Physics and 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 assist the low achievers to receive better support and necessary assistance in order to improve their performance and to bridge the academic gaps among the high, medium and low achievers.

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