

Effects of Team-Pair-Solo Cooperative Learning Strategy on Senior Secondary Two Students' Achievement in Physics in Jos Metropolis, Nigeria

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Abstract

This study investigated the effects of Team-Pair-Solo cooperative learning strategy (TPS) on senior secondary two students' achievement in physics in Jos metropolis, Nigeria. Students' achievement in physics has continued to fluctuate in Nigeria, exhibiting traces of under-achievement, over the years. The pre-test, post-test non-equivalent control group quasi-experimental research design was used. The sample size of 88 students offering physics from intact classes in two schools, obtained by the purposive and simple random sampling techniques, was used for the study. The experimental group consisted of 22 male and 20 female students while the control group consisted of 27 male and 19 female students. The instrument developed for the study was the Physics Achievement Test (PAT) which consisted of 40 multiple-choice items in the concepts of motion, heat energy measurements and linear momentum. The reliability coefficient of PAT, using the Kuder-Richardson formula 20 on SPSS version 25, was determined as 0.91. The mean was used to answer three research questions raised for the study and the t-test was used to test the two formulated hypotheses at $\alpha = 0.05$ level of significance. Findings from the study revealed that students taught using TPS achieved higher in physics than those taught using conventional lecture method of instruction (CLM). It was also revealed that the TPS is gender-friendly. It was recommended that physics teachers should adopt the use of TPS; and that curriculum planners and education policy makers should incorporate TPS into secondary school physics curriculum so that teachers can effectively implement the strategy.

Keywords: *Cooperative Learning, Team-Pair-Solo Cooperative Learning Strategy, Students', Achievement, Physics, Students' Gender*

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Background to the Study

Physics is a branch of science that is concerned with the study of physical forces and their quantities such as matter and their relationship with energy. It is sometimes referred to as the science of measurement, observation and recording. Its knowledge has contributed greatly to the economic, industrial and technological development of nations. Josiah and Mankilik (2018), Usman and Opara (2018) were of the view that physics provides the basic knowledge and understanding of principles whose application contributes immensely to the quality of life in the society. Physics is one of the science subjects that are highly needed for any nation's technological breakthrough.

For a nation to develop in the area of economy and technology, the study of physics is needed to facilitate this development. Danjuma (2008) opined that physics plays a vital role in all human endeavours and serves as a pre-requisite for courses such as medicine, engineering, computer science, geology, agriculture, pharmacy and many others. It generates fundamental knowledge which is necessary for the required technological advancement needed to propel the economic engine of the world. It extends and enhances human understanding of scientific disciplines, exciting intellectual adventures and inspires dynamic frontiers of human knowledge about the environment. This means that the ultimate aim of physics teaching and learning should be the understanding of its scientific processes and application in everyday activities.

Physics is an important element to national development; it contributes to the technological infrastructure and provides trained personnel needed to take advantage of scientific advances and discoveries. Indeed, the knowledge of physics has led to so many inventions such as the production, application and utilization of integrated circuits, production and use of machines and other devices. It also accounts for the discovery and production of hydroelectric power, gas turbine and thermonuclear power plant, mobile phones, refrigerators, electrical heaters and cookers. Information and Communications Technology (ICT), which is a modern technology invention and has transformed the world into a global village, is also part of the benefits of physics through the application of its principles, laws and theories. Okoronka as cited in Ogunleye and Babajidede (2011) mentioned other benefits that are derivable from the knowledge of physics to include the construction of modern vehicles, rockets, nuclear bombs, missiles, drones, diodes, computers and other electronic systems. The principles of radiation used in modern medicine for diagnosis and treatment, the production and uses of so many appliances such as electronic gadgets, surgical and astronomical instruments are all traceable to the study of physics. The effective learning of the subject in schools is, therefore, desirable. Recently, the Joint Admission and Matriculation Board (JAMB), a body saddled with the responsibility of conducting the Unified Tertiary Matriculation Examination (UTME) and admitting candidates into tertiary institutions in Nigeria, pronounced the respective cut-off points for admission into Universities, Polytechnics and Colleges of Education as $\frac{160}{400}$, $\frac{120}{400}$ and $\frac{100}{400}$, for the 2020/2021 academic session. The implication of this pronouncement is that a minimum mean achievement score of 40.0%, 30.0% and 25.5% in the UTME is sufficient for secondary school students to be admitted into the Universities, Polytechnics and Colleges of Education to study any course of their choice (including

physics) during the 2020/2021 academic session, provided all other requirements are fulfilled. This attests to the further deterioration of education in the country.

In Nigeria, Physics is taught at the senior secondary school level of education; and, in spite of the importance and benefits of physics to national development, there is an under-achievement of students in physics (West Africa Examinations Council, WAEC, 2016). Researchers such as Boyo (2010), Josiah and Larina (2015), Josiah, Mallo and Inyang (2019) pointed to the lecture method of teaching physics most teachers use as one of the causes of the poor achievement of students in the subject. This method of teaching physics is teacher-centered and has contributed in producing unfavourable results. The under-achievement of students in physics may have negative effects to the health, economic, technological and industrial development of the nation. This concurs with the reasoning of Patrinos as cited in Akpan (2018) that education plays a pivotal role in the socio-economic development of a nation. There is the need, therefore, for physics teachers to shift from using the lecture method to methods that are student-centered as advocated by the government of Nigeria (Josiah, Mallo and Inyang, 2019), which will improve students' achievement in physics towards improving the socio-economy of the nation. Physics instruction should be prepared in a manner that will cause a change in the behaviour of students. This change should be in cognizance of the student's self confidence in solving problems in physics. It is evident from the foregoing that physics teachers should strive to search for better teaching and learning methods that will enable physics students gain proper understanding of the principles and applications of physics concepts. The choice of any or some of these methods of teaching physics depends on the how the teacher plans his lesson towards achieving stated behavioural objectives. The method of teaching the teacher chooses to use should have a significant influence on the students' learning outcomes.

Cooperative learning is a method of teaching in which small groups, each with students of different levels of learning abilities, use some learning activities to improve their understanding of the subject. Each member of a cooperative learning group is responsible not only for learning what is taught but also for helping group members learn thus, creating an atmosphere of achievement. Cooperative learning is a constructivist method. More specifically, cooperative learning is based on the model that knowledge can be created within a population where members actively interact by sharing experiences and take on asymmetry roles (Mitnik, Recabarren, Nussbaum & Soto, 2009). Cooperative learning refers to methodology and environment in which learners engage in a common task where each individual depends on and is accountable to each other (Adolphus, Alamina, Aderonmu and Nkpolu, 2013). It is a learning method which involves group of learners working together to solve a common problem, complete a task, or create a product. Using this approach in learning requires students to be active participants in the learning processes in which they assimilate information and relate the new knowledge to their cognitive structure for future utilization and subsequent task. Cooperative learning is student-centered.

There are many strategies of cooperative learning, some of these include: Jigsaw, Three-Step Interview, Round Table or Rally Table, Student Team Achievement Division (STAD), Team Game Tournament, Round Robin Brainstorming and Team-Pair-Solo (TPS), TPS is a strategy

of cooperative learning where by students are grouped into teams. First, they solve problems as a team, then paired, and finally on their own (that is individually or solo). A team works a problem to completion before splitting into pairs. The pairs then work a similar problem together and then splits into solo (individual) students who are individually presented with the same type of problem (Kagan in Ogunleye, 2011). TPS encourages students' active participation in the teaching-learning process; consequently, it encourages students towards better learning and achievement. Studies have been undertaken on the effects of cooperative learning on students' achievement in learning. Ogunleye (2011) carried out a study on Team Pair Solo cooperative learning (TPS) and personality type as determinants of students' achievement and attitude to chemistry. The researcher found out that TPS was more effective in facilitating learning than the conventional instruction. Wachanga as cited in Williams, Fred and Samuel (2014) explored the effects of traditional and cooperative learning strategies on students' achievement and motivation in secondary school chemistry. The researcher found out that the students who were taught using cooperative learning achieved significantly higher in chemistry than those who were taught using traditional method.

There are evidences that indicate that gender influences students' achievement. Kolawole (2008) investigated the effects of competitive and cooperative learning strategies on the achievement of students in mathematics and reported that the male students achieved significantly higher than the female students in both learning strategies. In contrast, Ajaja and Eravwoke's (2010) study found no significant difference between the achievement of male and female students in integrated science when they were exposed to cooperative learning.

Statement of the Problem

Physics is a fundamental science subject which serves as a basis for the socio-economic development of any nation. In spite of this, students' achievement in the subject in Jos metropolis, Nigeria has continued to fluctuate, exhibiting traces of under-achievement, over the years. Gambari as cited in Adegbija and Falode (2014) attributed the poor achievement of students in physics to poor instructional strategies employed by teachers, amongst other factors. The methods of teaching persistently used by physics teachers in most secondary schools in Jos metropolis take the form which Josiah, Mallo and Inyang (2019) describe as students' passivity, note-copying and rote learning. These methods convey physics as boring and uninteresting, thereby affecting the students' achievement in the subject. It would therefore, be necessary to search for an effective teaching strategy which may improve students' achievement in physics.

The use of instructional strategies such as Team-Pair-Solo cooperative learning strategy (TPS) in physics could help improve students' achievement in the subject. The study, therefore, intended to apply TPS in the teaching and learning of physics at senior secondary two and determine its effects on the students' achievement in the subject. It is apparent that little or no research on the effects of TPS on students' achievement in physics has been carried out in Jos metropolis. Therefore, this study aimed at investigating the effects of TPS on senior secondary two students' achievement in physics in Jos metropolis, Nigeria.

Research Questions

The following research questions were raised for the study:

1. What are the mean achievement scores in physics of senior secondary two (SS II) students before exposure to Team-Pair-Solo cooperative learning strategy (TPS)?
2. What are the mean achievement scores in physics of SS II students exposed to TPS and conventional lecture method of instruction (CLM)?
3. To what extent does the mean achievement score in physics of SS II female students exposed to TPS differ from that of their male counterparts?

Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance:

1. There is no significant difference between the mean achievement scores of SS II students taught physics using TPS and those taught using CLM.
2. There is no significant difference between the mean achievement scores of SS II male and female students taught physics using TPS.

Methodology

This study employed the quasi-experimental design. Specifically, the pre-test post-test non-equivalent control group design. This implies that intact classes (non-randomized groups) were used for the study such that the researchers avoided disrupting the academic programmes of the sample schools. The population of the study comprised 2,450 senior secondary two (SS II) students (1,324 male students and 1,126 female students) from the 103 government-approved secondary schools in Jos Metropolis, Plateau State, Nigeria. Purposive sampling and simple random sampling techniques were adopted to obtain a sample of 88 students from two intact classes. Purposive sampling technique was used to obtain the two sample schools, from where one intact class each of SS II students offering physics as a subject was selected. Thereafter, simple random sampling technique was used to place the two schools into experimental and control groups. The experimental group comprised 42 students made up of 22 male students and 20 female students, while the control group consisted of 46 students made up of 27 male students and 19 female students. The criteria used to obtain the two schools were as follows:

1. The school must be co-educational; and
2. The intact class must have a qualified physics teacher who must have at least a B.Sc (Ed) in physics and must have been teaching in the school for at least six years.

The instrument used together data for the study was the Physics Achievement Test (PAT) developed by the researchers. It comprised of 40 multiple-choice items with each item having four options labeled A, B, C and D. The items were drawn from the SS II physics syllabus (on the concepts of motion, heat energy measurements and linear momentum) and Senior School Certificate Examination (SSCE) past question papers organized by West African Examinations Council (WAEC) and National Examinations Council (NECO), using table of specifications based on Bloom's Taxonomy. The instrument was used to measure students' achievement in physics before and after treatment with Team-Pair-Solo cooperative learning strategy (TPS). PAT was validated by experts in the University of Jos, Nigeria. The reliability coefficient of PAT was determined as 0.91 using Kuder-Richardson formula 20 (K-R 20) on the Statistical Package for the Social Sciences (SPSS) Software Version 25.

PAT was administered to both the experimental and control group's aspre-test, before the treatment. Thereafter, the students in the experimental group were taught the concepts of motion, heat energy measurements and linear momentum using TPS by one of the research assistants for a period of six weeks. During the same period that the students in the experimental group were treated with the TPS, the students in the control group were merely being taught the same concepts of motion, heat energy measurements and linear momentum using the conventional lecture method of instruction (CLM) by the second research assistant. After the treatment, PAT was administered as post-test to the two groups using face-to-face or on-the-spot method as in the pre-test administration. The mean, a descriptive statistics was used to answer all the research questions and t-test was used to test all the hypotheses at $\alpha = 0.05$ level of significance.

Results

Research Question One

What are the mean achievement scores in physics of senior secondary two (SS II) students before exposure to Team-Pair-Solo cooperative learning strategy (TPS)?

Table 1: Mean Achievement Scores of SS II Students in Physics before Exposure to TPS

Group	N	Mean	SD
Experimental	42	45.10	6.10
Control	46	46.61	5.78

Table 1 shows the mean achievement scores of SS II students before exposure to Team-Pair-Solo cooperative learning strategy (TPS). The finding reveals that the mean achievement score in physics of the experimental group (45.10) did not differ much from that of the control group (46.61).

Research Question Two

What are the mean achievement scores in physics of SS II students exposed to TPS and conventional lecture method of instruction (CLM)?

Table 2: Mean Achievement Scores of SS II Students in Physics after Exposure to TPS and CLM

Group	N	Mean	SD
Experimental	42	67.75	8.75
Control	46	50.45	5.78

Table 2 shows the mean achievement scores of SS II students after exposed to TPS cooperative learning strategy and conventional method of instruction. The result reveals that after being taught physics using TPS the experimental group had a higher mean achievement score of 67.75 in physics, compared to the mean score of the control group (50.45) that was taught using CLM.

Research Question Three

To what extent does the mean achievement score in physics of SS II female students exposed to TPS differ from that of their male counterparts?

Table 3: Mean Achievement Scores of SS II Male and Female Students in Physics after Exposure to TPS

Gender	N	Mean	SD
Male	22	69.35	8.40
Female	20	66.15	8.47

The result in table 3 revealed that the male students who were taught physics using TPS had a mean achievement score of 69.35 while their female counterparts who were exposed to the same treatment had a mean achievement score of 66.15. This indicates that there was no much disparity between the mean achievement scores of both the male and female students who were exposed to learning using TPS.

Hypotheses One

There is no significant difference between the mean achievement scores of SS II students taught physics using TPS and those taught using CLM.

Table 4: t-test Analysis on Effects of Team-Pair-Solo Cooperative Learning Strategy on Student's Achievement in Physics

Group	N	Mean	SD	DF	T Value	P Value	Decision
Experimental	42	67.75	8.75	86	13.06	0.006	rejected Ho
Control	46	50.45	5.78				

Table 4 shows that at $\alpha = 0.05$ ($t=13.06$, $df=86$ and $P=0.006$). Since $P<0.05$, the null hypothesis was rejected. Inference was, therefore, drawn that a significant difference between the mean achievement scores of SS II students taught physics using TPS and those taught using CLM existed.

Hypotheses Two

There is no significant difference between the mean achievement scores of SS II male and female students taught physics using TPS.

Table 5: t-test Analysis on Effects of Team-Pair-Solo Cooperative Learning Strategy on SS II Male and Female Students' Achievement in Physics

Gender	N	Mean	SD	DF	T Value	P Value	Decision
Male	22	69.35	8.40	40	1.968	0.944	accepted Ho
Female	20	66.15	8.47				

Table 5 shows that, at $\alpha = 0.05$ ($t = 1.968$, $df=40$ and $P=0.944$). Since $P>0.05$, the null hypothesis was not rejected. This implies that there was no significant difference between the mean achievement scores of SS II male and female students taught physics using Team-Pair-Solo cooperative learning strategy.

Discussion

The finding from table 1 indicates that the achievement level of the students from both sampled schools was the same (poor), before treatment of Team-Pair-Solo cooperative learning strategy (TPS). However, the finding from table 2 shows that the students who were taught physics using TPS had a higher mean achievement score than their counterparts who were taught with the conventional lecture method of instruction CLM. Furthermore, the finding from table 4 revealed that students taught physics using TPS achieved significantly higher than those taught physics using CLM. This agrees with the finding of Wachanga as cited in Williams, Fred and Samuel (2014) that students who were taught using cooperative learning achieved significantly higher in chemistry than those who were taught using traditional method. It implies that the TPS helped students to understand physics concepts and to achieve high in the subject.

From table 3, the mean achievement scores of both SS II male and female students who were exposure to physics using TPS did not differ much. The male students had a mean score of 69.35, while the female students had a mean of 66.15. The finding from table 5 indicates that there was no significant difference between the mean achievement scores of the female students who were exposed to physics using TPS and their male counterparts who were exposed to the same treatment. This is in agreement with the findings of Ajaja and Eravwoke (2010) which showed that cooperative learning did not significantly affect students' achievement in integrated science, when gender was considered. The finding from table 5 is, however, discordant with the findings of Kolawole (2008) and Adeyemi (2008) that when students were exposed to learning using cooperative learning strategy, male students achieved significantly higher than female students. This implies that when students are exposed to learning physics under Team-Pair-Solo cooperative learning their achievement is enhanced.

Conclusion

The Team-Pair-Solo cooperative learning strategy (TPS) is suitable for teaching physics in secondary schools in Nigeria. This is because the strategy has been found to have a positive effect on secondary school students' achievement in physics. The strategy has also been found to be gender friendly; it does not discriminate against gender.

Recommendations

Based on the findings of the study, the researchers recommended the following:

1. Physics teachers should adopt the use of Team-Pair-Solo cooperative learning strategy (TPS) because it enhances students' achievement and it is not gender-biased.
2. Curriculum planners and education policy makers should incorporate TPS into secondary school physics curriculum so that teachers can effectively implement the strategy in schools.

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