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Effect of Team-Pair-Solo Instructional Strategy on Biology Students' Achievement and Retention in Transport System in Ado Local Government Area of Ekiti State

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Abstract

The study assessed the effect of Team-pair-solo Instructional Strategy (TIS) on students' achievement and retention in the transport system in Ado Local Government Area of Ekiti State. It also assessed the effect of the strategy on students' achievement in relation to gender. Three research questions and hypotheses guided the study. A quasi-experimental pretest-posttest on-equivalent control group design was used for the study. The population of the study consisted of 210 S.S.II Biology students in the 6 co-educational secondary schools in Ado Local Government Area of Ekiti State. The study sample consisted of 54 Biology students in their intact classes from two randomly selected secondary schools in the study area, consisting of 11 male and 17 female students. The classes were randomly assigned to one experimental and one control group in each of the two schools. The experimental group was taught using TIS while the control group was taught using the Conventional Teaching Method CTM). The instrument for data collection was the Biology Achievement Test on Transport System (BATTS). The same instrument but in a rearranged version was also used to collect data on retention. Descriptive statistics of mean and standard deviation were used to answer the research questions, while inferential statistics of Analysis of Variance (ANOVA), Analysis of Covariance (ANCOVA) and T-test were used to test the formulated hypotheses one, two and three respectively, at 0.05 alpha level. Findings of the study revealed that TIS and CTM had significant effect on Biology students' achievement in transport system $F_{(3, 107)} = 33.066$, $p = .000$. The results also showed that those exposed to TIS had greater mean posttest achievement score (mean =61.14) than those exposed to CTM (Mean =46.95). On students' retention, TSIS and CTM were found to have a significant difference ($F_{(1, 51)} = 12.792$), $p = .001$. The results showed that those exposed to TSIS had a higher retention score (Mean =51.36) (retained more knowledge of the concept taught) than those exposed to CTM (Mean =37.04). Based on the findings, the study recommends, among others, that since TIS had a significant effect on students' achievement and retention, it should be recommended for all Biology teachers at the secondary school level as an instructional strategy to be used in teaching their lessons.

Keywords: Transport System; Academic Achievement, Retention, Team-pair-solo

Introduction

Biology is one of the science subjects offered by science students in senior secondary schools in Nigeria. Biology is a vital aspect of science education, which is concerned primarily with the study of life. In Nigeria, the secondary school Biology curriculum is designed to continue students' investigation into natural phenomena, deepen their comprehension and interest in the biological sciences and also encourage students

to apply scientific knowledge in their day-to-day activities. Despite the importance of Biology as a subject, students' performance at external examinations such as the West Africa Examination Council (WAEC) and the National Examination Council (NECO) has been consistently unsatisfactory over the years (Adekunle and Femi-Adeoye, 2016). More recent reports of students' performance in the West Africa Examinations Council showed that 50.02%, 35.82% and 39.38% failed Biology in 2018, 2019 and 2020, respectively. While this trend calls for immediate attention of all stakeholders in the field of Biology, more effective strategies where the students will be active participants during teaching and learning have been advocated (Williams, Cheta, and Kufre, 2017).

Transport system, which is central to this study, is a prominent topic in Biology and has also been marked as one of the topics in biology that students have difficulties in examination forms an integral part of Biology, taking into account its relevance and centrality in the Biology curriculum. Transport system is an integral aspect of biology that is concerned with the study of how metabolic materials from various parts of organisms move from where they are produced or secreted to other parts where they are stored, used or removed from the body. It is a vital aspect of biology that puts all categories of organisms, ranging from the microscopic to macroscopic ones, into consideration in relation to how their substances and secretions are transported within their body system. In secondary schools in Nigeria, studies have shown that the dominant teaching method is the conventional method, such as the lecture method, expository method, and talk-and-chalk method. These methods are characterized by memorization and recall of facts by students (Omoifo, 2012). In these teaching methods, the teacher is placed at the central wheel while the students are held redundant, inactive, and are seen as spectators, hence being at the losing end (Chukwu and Arakoyu, 2019). However, continuous use of the conventional method will yield nothing but learning by rote, which will make it difficult for students to; recall pieces of information from memories, construct their own knowledge meaningfully and embark on critical thinking all of which may hinder meaningful learning and eventually result to poor or unsatisfactory performance in examinations. In an attempt to ensure good and result–oriented Biology delivery in schools, Wasserman (2017) suggested the use of interaction-based oriented strategies such as team-pair solo, jigsaw, think-pair-share, guided inquiry, demonstration and many others. However, for the sake of this study, the team-pair solo instructional strategy will be used.

Team-pair-solo Instructional Strategy (TIS) was proposed by Kagan in the year 2001. It is a strategy in which students solve problems first as a team, then with a partner, and finally on their own. It is a strategy that facilitates greater interaction among students. In TIS, students are grouped into teams. In TIS, a team accomplishes a specific task to completion before splitting into pairs. The pairs then accomplish a similar task together and then split into solo (individual) students who are individually presented with the same task. TIS was designed to motivate students to succeed at problems that are initially beyond their abilities. It is based on a simple notion of mediated learning. Students can do more things with help (mediation) than doing alone. By allowing students to work in team and also in pairs the problems they could not solve alone would be easier to be solved collectively Chiakwelua and Okigboe (2020). It implies that TIS can make students interact actively in the class activity, especially in gaining mastery of some concepts. Also, it stimulates students to think. TIS builds confidence in students when attempting more difficult content materials. It means that the Team-pair solo instructional strategy can make students to be confident in learning because they have tried to solve the problem in team and pairs before solving it on their own. This is comparable to the workplace where an individual is expected to play a role to achieve a common goal. It is a strategy that leaves students as experts and receivers of knowledge. Nilson, (2016) stated that joint learning and sharing of knowledge, allow learners to discuss the subject and be responsible for their learning to enhance their achievement and retention.

Achievement is the amount of academic content a student learns in a specific time period. is often measured through examinations or

continous assessments. It is the extent to which a student has acquired either short- or long-term educational goals. It may be measured through, testing, student's grade and point average. Retention is the ability to store what has been learnt and recall what has been stored in the memory. It is the ability of the learner to reproduce a learned behaviour in due time. Therefore, a learner who repeats an acquired knowledge with less error is said to have retained the material learnt Ashlame and Iwanger, (2019). More so, when what is taught is not retained, learning becomes incomplete. Retention of concepts is an important factor in discerning students' achievement in a given task, problem or assignment. This means that high retention may lead to high achievement, which is a factor of many variables such as the interval between learning and retrieval, intervening experiences, specific subject involved, teaching strategies/methods used, and environmental situations, among others. Students should be able to retain knowledge from information obtained from lessons to benefit from the learning. As such, a teacher's job remains incomplete until he or she has assisted the learner in retaining knowledge of the information learnt. When students cannot recall what they have learnt before, they become more confused. Such confusion can be the beginning of a lack of interest in the subject or concept being taught. Some topics, such as evolution, genetics and transport systems in Biology, are a few areas where students often find it difficult to understand and are often told in their scores during marking, according to WAEC's Biology Chief Examiner's report (2020).

Gender imbalance in science has been an age-old issue among researchers. Research findings are not explicit on the effect of gender on achievement, particularly as it moderates the effectiveness of teaching strategies. Unity and Igbudu (2015) found no gender difference in the academic performance of the two genders which was earlier conceived to contribute to the disparities in the allocation of cognitive roles in the world of work and the earlier position that males have larger average brain sizes than females and would be expected to have higher degree of intelligent quotient. More so, Mobark (2014) found no significant difference in the academic performance of male and female students. Falemu, Oyeniyi, and Adumati (2017), observed a significant difference in the academic performance of male and female students in Biology in WAEC examination results in favour of female Biology students. Since studies conducted on gender showed that there are inconsistencies in the conclusions reached by the previous studies, therefore, there is a need to ascertain the effect of TIS on the achievement of male and female students in the transport system in Biology.

Several empirical studies have demonstrated the effect of TIS in many subjects like Chemistry and Physics when compared to the conventional teaching strategy (Macmillan and Alhamdu (2020). However, no study has assessed the effect of TIS on students' achievement and retention in the transport system, which is a vital aspect of Biology; hence, the need for this study. Therefore, could this instructional strategy be used to enhance students' academic achievement and retention in the transport system, which is a vital aspect of biology? Hence, the study intends to look into the effect of team-pair-solo instructional strategy on biology students' achievement and retention in the transport system in Ado Local Government Area of Ekiti State.

Research Questions

The following research questions guided this study:

1. Is there a difference in the mean pretest-posttest achievement scores of Biology students taught transport system using Team-pair-solo Instructional Strategy (TIS) and those taught with the Conventional Teaching Method (CTM) in Ado Local Government Area of Ekiti State?
2. Is there a difference in the mean post and retention test scores of Biology students taught transport system using Team-pair-solo Instructional Strategy and those taught with the Conventional Teaching Method in Ado Local Government Area of Ekiti State?
3. Is there a difference in achievement by gender of students taught the transport system using TIS?

Hypotheses

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

HO_1: There is no significant difference in the mean pre- and posttest achievement scores of Biology students taught transport system using TSIS and those taught with CTM

HO_2: There is no significant difference in the mean post and retention test scores of Biology students taught transport system using TSIS and those taught with CTM.

HO_3: There is no significant difference in achievement by gender of Biology students taught the transport system using TIS.

Methods

This study employed the quasi-experimental pretest-posttest non-equivalent control group research design. The quasi-experimental design was used because students in their intact classes were used, and there was no randomization of subjects into groups. The independent variables in the study were the instructional strategy, teaching method, while the dependent variables were students' achievement and retention. The population of this study consisted of 210 S.S.II Biology students in the 6 Co-educational secondary schools in Ado Local Government Area of Ekiti State. The study sample consisted of 54 SS II Biology students in their intact classes from the two randomly selected schools in Ado Local Government Area of Ekiti State. The two schools were randomly assigned to the control and experimental groups. The experimental group was exposed to a team-pair-solo instructional strategy while the control group was exposed to the conventional method of teaching

Biology Achievement Test on Transport System (BATTS) and Biology Students Retention Test on Transport System (BSRTTS) were the instruments for data collection. BATTS is divided into two parts. Part A elicited the bio-data of the students, while Part B is made up of 25 multiple-choice objective test items with four options on the transport system in SS II biology syllabus. The researcher used the instrument during the pre-test, and the same instrument was reshuffled and used as a post-test. This instrument was reshuffled again and used as a retention test. The post-test was conducted in the sixth week of the experimental study, while the retention test was administered two weeks after the post-test. The BATTS was validated by experts from the Department of Curriculum and Instructional Technology and Measurement and Evaluation Unit of the Educational Foundations Department at the University of Benin, Edo State, Nigeria. To establish the validity of the BATTS, the lesson plans, title, purpose, scope, research questions and hypotheses with the BATTS were given to the experts. The corrections, recommendations and suggestions of these experts were incorporated in the final production of BATTS. The content validity was ensured using a table of specifications by Bloom. A pilot test was carried out to determine the reliability of the instrument (BATTS). A co-educational school, which was not part of the main study, was used for the pilot study. The instrument was administered for a period of 40 minutes, after which they were retrieved by the researcher. The scores obtained from the 20 (SSII) students who participated in the pilot study were subjected to the Kuder Richardson formula 20 and found to have a reliability index of 0.85. Data obtained were analyzed descriptively and inferentially. Descriptive statistics of mean and standard deviation were used to answer the research questions. Hypothesis one was tested using Analysis of Variance, while hypothesis two was tested using Analysis of Covariance. All the hypotheses were tested at 0.05 level of significance using the SPSS program version 20.

Research Question 1: What is the mean pre-test score of the students across the two teaching strategy groups?

Table 1: Difference between the mean pretest-posttest achievement scores of SS 2 students taught transport system using Team-pair-solo Instructional Strategy (TIS) and Conventional Teaching Method (CTM).

		Pretest		Posttest		
Groups	**N**	**Mean**	**SD**	**Mean**	**SD**	**Mean Gain**
Experimental	28	22.07	6.57	61.14	9.05	31.07
Conventional (Control)	26	22.62	5.45	46.95	9.85	24.33

The data in Table 1 shows that the experimental group got a mean score of 22.07 and a standard deviation of 6.57 in the pretest and a mean score of 61.14 and a standard deviation of 9.05 in the posttest, making a pretest-posttest mean gain of 31.07. The Table also shows that the control group got a mean score of 22.62 in the pretest, a standard deviation of 5.45 and a mean posttest score of 46.95 and a standard deviation of 9.85 in the posttest, giving rise to a pretest-posttest mean gain of 24.33. This result indicates that the students achieved more in the posttest than in the pretest. This result further indicated that the experimental group (TIS) got a higher mean gain than the control group (CTM).

HO_1: There is no significant difference in the mean pre- and posttest achievement scores of Biology students taught transport system using TSIS and those taught with CTM

To test the hypotheses, the students' scores on the mean and observed differences in the mean pretest of the two groups, ANOVA was used. The result of the analysis is shown in Table 2 below;

Table 2. T-test on the mean pretest scores of the Experimental and Control groups

Groups	N	Mean	SD	df	t	p	Decision
Experimental	28	22.07	6.57				
Control	26	22.62	5.45	52	.330	.74	Accept Ho

The above preliminary investigation on the pretest of the two groups shows no significant difference, $\alpha = 0.05$(t=.330, df=52 and p=.074). Conventionally, since there was no difference at pretest, the appropriate statistics to use for hypothesis one is ANOVA. To conclude on the mean and observed differences in the mean pretest and posttest achievement scores, ANOVA was used. The result of the analysis is contained in Table 3 below.

Table 3: ANOVA test of significant difference between the mean pretest-posttest achievement scores of SS 2 students taught transport system using TIS and CTM

	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	8095.886	3	2698.629	33.066	.000
Within Groups	8487.780	104	81.613		
Total	16583.667	107			

Table 3 shows the ANOVA of pretest-posttest achievement scores of students taught the transport system using team-pair solo, and the conventional method. The result indicates that $F_{(3, 107)} = 33.066$, $p = .000$, which is significant at 0.05 alpha level. This means that there is a significant difference in the mean pretest-posttest achievement scores of Biology students taught transport system using team-pair-solo and the conventional teaching method. Therefore, the null hypothesis of no significant difference is rejected.

Research Question 2: Is there a difference in the mean post and retention tests scores of Biology students taught transport system using Team-pair-solo Instructional Strategy and those taught with the Conventional Teaching Method in Ado Local Government Area of Ekiti State?

Table 4, shows the difference between the mean post and retention tests scores of SS2 students in the two groups.

Table 4: Difference between the mean post and retention tests scores of SS 2 students taught transport system using Team-pair-solo Instructional Strategy (TIS) and Conventional Teaching Method (CTM).

		Posttest		**Retention**		
Groups	**N**	**Mean**	**SD**	**Mean**	**SD**	**Mean Gain**
Experimental	28	61.14	9.05	51.36	6.18	9.78
Conventional (Control)	26	46.95	9.85	37.04	10.62	9.91

Table 4 shows that the experimental group got a mean score of 61.14 in the posttest, a standard deviation of 9.05, a mean retention score of 51.36 and a standard deviation of 6.18 thereby resulting to a posttest-retention mean gain of 9.78 while the control group had a mean score of 46.95 in the posttest, a standard deviation of 9.85, a mean retention score of 37.04 and a standard deviation of 10.62 thereby resulting to a posttest-retention main gain of 9.91. This result indicates that the experimental group had a higher mean retention score. More so, the table indicated that the control group got a higher mean gain than the experimental group. To conclude on the mean and observed differences in the students' retention on the transport system, a preliminary investigation that was carried out on the posttest scores of the two groups showed a significant difference $F_{(3, 107)} = 33.066$, $p = .000$, significant at 0.05 alpha level. Based on the results of the preliminary investigation carried out on the posttest, the most appropriate statistical tool to use is

HO_2: There is no significant difference in the mean post and retention test scores of Biology students taught transport system using TSIS and those taught with CTM.

To test this hypothesis, the students' score was subjected to a test of between-subject effect through ANCOVA with the posttest serving as the covariate. The result is presented in Table 5.

Table 5: ANCOVA test of significant difference between the mean post and retention test scores of SS 2 students taught transport system using TIS and CTM.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3189.989[a]	2	1594.995	23.761	.000	.482
Intercept	1193.407	1	1193.407	17.779	.000	.153
Posttest (Covariate)	425.954	1	425.954	6.346	.015	.061
Retention	854.432	1	854.432	12.729	.001	.114
Error	3423.436	51	67.126			
Total	113369.000	54				
Corrected Total	6613.426	53				

a. R Squared = .482 (Adjusted R Squared = .462)

Table 5 shows the ANCOVA of students' retention using the team-pair-solo instructional strategy and the conventional method of teaching. The result indicated that $F_{(1, 51)} = 12.792$, $p = .001$ significant at 0.05 alpha level. The results also showed that treatment accounted for 11.4% of the variance in the dependent variable. This means that there is a significant difference in the retention ability of students taught transport system using the Team-pair-solo Instructional Strategy and the Conventional Method of Teaching in favour of TIS group. Therefore, the null hypothesis of no significant difference is rejected.

Research Question 3: Is there a difference in achievement by gender of students taught the transport system using TIS?

HO3: There is no significant difference in achievement by gender of Biology students taught the transport system using TIS.

Table 6: Mean Achievement Scores of Male and Female Students in the Transport System at Posttest.

Gender	N	Mean	Standard Deviation
Male	11	62.27	7.35
Female	17	60.41	10.16

The result in Table 6 shows the mean achievement scores for male and female students taught the transport system using the Team- pair-solo instructional strategy. From the table, the male students had a mean score of 62.27 and a standard deviation of 7.35, while the female students had a mean score of 60.41 and a standard deviation of 10.16. However, the result reveals a slight difference in achievement in favour of the male students. The statistical analysis to show if this difference is significant is displayed in the next table.

Table 7: T-test significance difference in achievement of Male and Female Students taught Transport system using Team-pair-solo Instructional Strategy

Gender	N	Mean	SD	df	t	P	Decision
Male	11	62.27	7.35				
Female	17	60.41	10.16	26	.524	.605	Accept Ho

The result in Table 7 shows that at α 0.05 (t=.524, df=26 and p=.605). Since p > 0.05, the null hypothesis is retained. Hence, there is no significant difference in achievement between male and female students taught the transport system using the TPSIS.

Results and Discussion

The findings revealed that the students taught with TIS achieved more than those taught using the CTM. This suggests that the TIS had superiority over the CTM in enhancing students' achievement in the concept taught. The results also revealed a significant difference in achievement of students taught transport system using the TIS and those taught using CTM in favour of the TIS group. The researcher ascribes this difference to the interactive-engagement feature of the strategy in enhancing students' understanding of the concept taught. This finding is in agreement with Chiakwelua and Okigbo (2020), who found that TIS enhanced students' achievement in Mathematics more than the conventional method. More so, the study is in consonance with Macmillan and Alhamdu (2020), who observed a significant positive change in the academic achievement of students in physics after being taught with TIS. The findings conducted by the researchers revealed that students who were taught physics with TIS had better mastery of the concept taught than their peers who were taught with the conventional method.

In addition, the findings from this study are in support of Meliza, Hermawati and Zul (2018) who carried out a study titled effect of Team-pair-solo technique on Students' Reading Comprehension of Narrative Text at Grade IX of SMPN 14 Pekanbaru and found that students that were exposed to TIS as a medium of instruction were found far better than those who were exposed to lecture method. Similarly, Santi and Jombang (2017) in their study titled Effectiveness of using Team-pair solo strategy in teaching writing descriptive text for the Second Grade Students in Smpn 2 Peterongan found TIS to be highly effective than the conventional method.

The findings also revealed that students taught using TIS retained more of the concept taught than their counterparts that were taught using the CTM. The researcher attributed better retainment in favour of the TIS group to the fact that TIS group were made to partake and also construct their learning on their own thereby making it easier for them to recall the learnt concept more than their counterparts who were passive and spoon-fed. The results also revealed a significant difference in post and retention scores of students taught transport system using the TIS and those taught using CTM in favour of the TIS group. More so, this could be attributed to what Bioexplorer (2018) posited that students learn better, retain more knowledge and re-integrate the gained knowledge when being allowed to learn with peers and share knowledge with colleagues.

The findings from this study are in agreement with the study carried out by Epifanio and Denis (2018), who observed that students who were taught mathematics using the DCL of Team-pair-solo instructional type had better retention scores in mathematics than those taught with the non-DCL method. More so, the study is in support of Ogunleye (2017), who found out that students who were taught Chemistry using TIS retained more of the concept taught than their counterparts who were taught using the traditional method. He observed that TIS students were able to recall some chemical concepts that were taught over time. The outcome of this study is also in

alignment with Fitriani, Wijayatiningsih and Armah (2016), who discovered that students who were taught writing procedures using TIS had better writing skills and also retained more of the technicalities of writing than those taught using the Think-pair-share instructional strategy.

More so, the findings from this study reveal that there was no significant difference in the achievement of male and female students taught the transport system using TIS. Although there was a slight difference in favour of the male, but not statistically significant. This result agrees with the findings of Falemu, Oyeniyi & Adumati (2017), who found no significant difference in the academic performance of male and female Biology students in MOCK examination results in secondary schools in Ado local government area of Ekiti State. Furthermore, the findings of this study are in line with Funmilayo (2012), who observed that gender had no significant main effect on students' performance and neither were there interaction effects of treatment and gender on students' self-efficacy.

In contrast, the study negates Eseine-Aloja, (2021) who carried out a study on the effects of gender on the academic performance of biology students in extra-mural classes in public senior secondary schools in Esan Central Local Government Area of Edo State. The result of his findings revealed a significant difference in academic performance in favour of male students. Also, the outcome of the study also negates Oyovwi (2019), whose study revealed a significant difference in the mean achievement score of male and female students taught biology using a self-regulated learning strategy.

Conclusion

This study showed that students who were taught the transport system using a team-pair-solo instructional strategy had better achievement and retained more knowledge of the concept than those taught using the conventional method. More so, the strategy enhanced the achievement of both male and female students. In fact, TIS has demonstrated its effectiveness in increasing meaningful learning through the cross-fertilization of ideals among students with different learning abilities. Its interactive-engagement quality also made learning more participatory and increases learners' achievement and retention without being bias in relation to gender. It is therefore recommended that teachers at all levels should embrace and constantly use this instructional strategy in teaching their students for maximum productivity in terms of achievement and retention.

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