IOSR Journal of Research & Method in Education (IOSR-JRME)
e-ISSN: 2320–7388, p- ISSN: 2320-737x Volume 11, Issue 2 Ser. IV (Mar. – Apr. 2021), PP 42-48
www.iosrjournals.org

Effect of Think-Pair-Share Teaching Strategy on Secondary School Students' Achievement in Chemistry in Cross River State

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Abstract: *The study investigated the effect of think-pair-share strategy on secondary school students' academic achievement in chemistry. Two research questions guided the study and six hypotheses were tested at 0.05 level of significance. The quasi-experimental design was adopted for the study. The population of the study was 2, 345 senior secondary school year two (SS2) chemistry students in Abi local government area of Cross River state out of which a sample of 121 students obtained using purposive and random sampling was involved in the study. The instruments for data collection was Chemistry Achievement Test (CAT) validated by two three experts. The reliability of the instruments were established using Kuder-Richardson Formula 20 for CAT to be 0.63. Data were collected by administering the instruments as pretest and posttest before and after treatment respectively. The data obtained were analyzed using mean, standard deviation and analysis of covariance. The findings of the study revealed that there was significant difference in the mean academic achievement scores of the students taught using think-pair-share and those taught using conventional method in favour of think-pair share strategy. It was recommended that workshops and seminars should be organized by school heads to orient chemistry teachers on how to effectively use think-pair-share strategy in the teaching and learning of chemistry.*
Keywords*: think-pair-share, strategy, chemistry, bonding, acid*

Date of Submission: 29-03-2021 Date of acceptance: 12-04-2021

I. Introduction

Chemistry is the study of the composition, properties, synthesis and use of matter. Chemistry as a field of study is interested in how different substances react with one another and the suitable conditions for these reactions. The science of chemistry is concerned with studying the atomic and molecular structure of matter to identify the properties of matter quantitatively and qualitatively (Ababio, 2011). It probes into obtaining new beneficial products that can be used in medicine, agriculture, engineering and industry. Chemistry is also concerned with treating some environmental problems such as rust, pollution of air, water and soil, the shortage of water and the energy resources.

Since the ancient civilization, chemistry has been related to metals, mining, production of colours, medicine and some technical industries like tanning, dyeing clothes and production of glass (Ababio, 2011). The pharmaceutical industry is one of the most important applications of chemistry. All food consists of chemicals even if they are organically grown. Fuel and all parts of car are made up of chemicals. Dyeing of fabrics is a chemical process and chemical reactions are involved in the production of electricity. Water treatment and purification is an important chemical method. The study of chemistry is important for the scientificdevelopment of a nation and for economic growth. Chemistry is one of the science subjects studied in secondary schools in Nigeria.

Secondary school chemistry teaches the basics to the understanding of chemistry and also prepares students who want to study chemistry at a future or higher level. Despite the importance of chemistry, students' achievement in secondary school chemistry in external examinations like Senior School Certificate Examination (SSCE) has remained poor (WAEC Chief Examiner, 2018). This problem is of great concern to science educators, researchers and chemistry teachers because the poor foundational knowledge could hamper effective study of chemistry in the future (Adekunle, 2015). Despite several efforts made to improve students' academic achievement in chemistry, performance of students in this very important subject has remained persistently poor.

The problem of poor achievement in chemistry is saddening, given that from 2007 to 2016, the Chief Examiner's Report showed that students raw mean scores have never been up to 50 which is the pass mark. This implies that the average performance of chemistry students for the past nine year have not appreciated to a pass mark by West African Examination Council standards. The Chief Examiner's Report showed amidst other things that students' lack practical knowledge of chemistry since their raw mean scores in chemistry practical examination over the years have never been up to 30. A lot of factors have been adduced for the poor

achievement in chemistry among which instructional methods adopted by chemistry teachers hold common place (Rasha, 2017, Usman, 2015).

The issues of instructional method often appear as one of the contributing factor to chemistry students' academic achievement because most methods adopted by chemistry teachers are teacher-centred. Many Nigerian secondary schools lack the facilities as well as the infrastructure needed for effective teaching and learning to ensure optimal learning of chemistry concepts (Sulaiman & Shahrill, 2015). In some cases, the chemistry teacher may not be conversant with innovative pedagogical approaches to teaching that can make the learning of chemistry more meaningful to the students. Consequently, students' academic achievement in chemistry has remained low.

Academic achievement is the outcome of instruction and students' mastery of particular learning contents (Pierre, 2010). It depicts the level to which students have successfully completed an academic task. Academic achievement is commonly determined by test and examination and other forms of assessments like assignments, project and class exercises. Academic achievement is often represented by grade scores. Thus, for a student to be admitted to study any related science course in the university, such student must make at least a credit pass in chemistry. Academic achievement is often improved when the teacher adopted learner-centred instructional strategies where students' are made to take responsibility for their own learning (Furquoun, 2015). Innovative teaching methods not only have the potential to improve achievement but can facilitate proper understanding of concepts learnt (Lom, 2012).One of such innovative teaching methods that hold promises of improving achievement in learning is think-pair-share strategy.

Think-Pair-Share (TPS) is a cooperative learning strategy that encourages students to work together to solve problems or answer questions on an assigned topic (Andrew &Alexandria, 2015). Think-pair- share as the name goes involves the students in thinking about challenging academic tasks given by the teacher individually, pairing with other students to exchange ideas and sharing the idea with the larger class. In the think-pair-share classroom, every student is an active learner. The teacher in this study used think pair share by developing a number of questions related to the objectives of the instruction and challenging the students to provide answers. The teacher will produce a chart of students seating arrangement so that students cannot chose the same person or their friends only by adhering to the chart. Using the chart, students are made to pair with a different student for each question to facilitate greater interaction.

During the interaction among pairs, students are expected to bring to the pair learning what they think is the solution to the problem, for which the teacher have given them time to think before pairing. The student pairs are to examine each other's solution to the problem, criticize or add to the solution or learn from it. Students in their pair may choose to solve the problem together with the ideas they have previously thought on their mind. This collaboration to solve a problem must result in a possible or at least tentative solution to the problem, which the students may now share with the entire class. The teacher appoints students at random looking at the chart to ensure that all the students are involved and that the intelligent ones do not dominate the activities. After the sharing, the teacher summarizes the lesson in the order of what students are supposed to learn.

Learning through think-pair-share shows that, by the intrinsic nature of the learning strategy, students can learn from their peer. It affords slow pace learners and shy students the opportunity to build self-confidence by learning from their peers (Marvin, 2015). Think-Pair-Share also improves students' desire to learn seeing that the task of learning is a collaborative effort where students can improve understanding of chemistry concept by sharing ideas. The thinking part of TPS facilitates students' active cognitive engagement in learning and reduces absent mindedness during instruction. TPS afford students the opportunity to take active role in their own learning through cognitive engagement, peer learning and sharing. Students synthesize and evaluate their ideas, or purported solutions to problems, apply them in understanding the solution better or in teaching their pair and further sharing their ideas with the whole class. These features of TPS bear good and positive prospect for the students' achievement in chemistry. Thus, the researcher is poised to investigate whether T-P-S would improve achievement in chemistry when compared to the conventional method of teaching.

The conventional method of teaching is what the teacher does in the classroom (Millis, 2012). Since most teachers use a mixture of different methods of instruction, one cannot really place the method of instruction adopted by the teacher in a conventional method class. However, most of the conventional methods are often teacher-centred. The conventional teaching methods have been shown to have no serious and positive effects on students' academic achievement in chemistry, hence, the persistently low achievement in teaching chemistry. There is need therefore, for chemistry teachers to adopt innovative teaching strategies in the teaching and learning of chemistry that could improve achievement irrespective of students' gender.

Gender is the state of being male or female (Suzanne, 2010). Different methods of instruction are either gender sensitive or gender bias. Effective teaching methods however, should improve academic achievement for male students much as it does for female students. This study therefore, seeks also to ascertain whether the use of TPS would be effective in improving academic achievement in chemistry equally for both male and female

chemistry students. The study of the interaction effect of gender and T-P-S on students' achievement will be necessary to inform chemistry teachers on how best to plan their instruction using TPS.

PURPOSE OF THE STUDY

The purpose of the study was to investigate the effect of think-pair-share strategy on students' achievement in chemistry. Specifically, the study sought to find out the:

1. difference in the mean achievement scores of students taught chemistry with think-pair-share strategy and those taught with conventional method.
2. difference in the mean achievement scores of male and female students taught chemistry with think-pair-share strategy
3. interaction effects of teaching methods and gender on students' achievement in chemistry.

RESEARCH QUESTIONS

The following research questions guided the study.

1. What is the difference in the mean achievement scores of students taught chemistry with think-pair-share strategy and those taught with conventional method?
2. What is the difference in the mean achievement scores of male and female students taught chemistry with think-pair-share strategy?

HYPOTHESES

The following hypotheses were tested at 0.05 level of significance:

1. There is no significant difference in the mean achievement scores of students taught chemistry with think-pair-share strategy and those taught with conventional method.
2. There is no significant difference in the mean achievement scores of male and female students taught chemistry with think-pair-share strategy.
3. There is no significant interaction effects of teaching methods and gender on students' achievement in chemistry.

II. Method

The design of the study is quasi-experimental, specifically the pretest-posttest non-equivalent control group design. The area of the study was Abi local government area of River state. The population of the study was 2, 345 (1,532 males, 813 females) SS2 chemistry students in 20 private schools and 11 public schools in Abi local government area of Cross River state. The sample for the study was 121 senior secondary school year two chemistry students. The sample was obtained using multi-stage procedure. First, the coeducational schools were listed out according to their locations. Secondly, two coeducational schools were purposively selected. The purpose of selecting the schools was because they took care of the gender variable in the study and are situated far apart to avoid class interaction and subject contamination. From the two schools selected, the schools were randomly assigned to experimental and control groups. The experimental group school has 23 males 37 females while the control group school has 33 males and 28 females.

The instrument for the study was Chemistry Achievement Test (CAT). CAT was made of 20 questions drawn from past WAEC questions on the concepts of acid and bases and chemical combination. The answer options are lettered A-D. To ensure adequacy of questions in the content areas taught, a table of specification was used to determine the number of question in the low and high order cognitions. Also, lesson plans were prepared on the concepts of acid and bases and metals for the treatment group using think-pair-share strategy. The control group lesson plan was on conventional method of teaching. The instrument was validated by lecturers in the Departments of Science Education and Educational Foundations. The reliability of the CAT was established using Kudder-Richardson 20 (KR-20). CAT was administered once to forty SS2 chemistry students in a school outside the area of study and the data generated was used to computer the internal consistency which yielded 0.63.

The treatment was preceded by the training of the research assistant that was used in the study. This was the regular classroom teacher. The training was done in one week under three contacts for two hours per contact. The treatment was conducted first by administering the pretest using CAT and CIS. No feedback on students' performance or revision was given. The students were oriented on the concept of think-pair-share. The teacher modeled for the students how to select their pair partner according to the serial numbering of the students in the classroom seated arrangement. For the entire treatment period, the serial arrangement were prepared on a chart and placed in the classroom so that students may know who their pairs are for the whole of the treatment exercise.

After the brief orientation, the teacher introduced the students to the topic of the first week and challenge them with questions on the objectives of the instruction. The teacher then gave the students a general

overview of what they are expected to bring back for their class presentation. To make the lesson organized, the students were given the topic of the lesson a week before the lesson. During each challenge, the student selected a different pair partner. The student would share their answer to the questions with their pairs and formulate answer for each questions. Students presented their answers in an organized manner and prepare to answer the questions in the general class after their presentation. To ensure active participation from all the students, the teacher chose at random, the students to answer the questions for each given lesson. At the end of the lesson, the teacher summarized the correct points of the lessons while correcting students on wrong answers given for the questions poised as a challenging task for the students. After the treatment, the same instruments used in the pretest were administered as posttest. The whole exercise lasted for six weeks involving one week for pretest and orientation on think-pair-share, four weeks of treatment and one week of revision and posttest.

The instruments were administered as pretest and posttest. The data generated from the tests were organized and analyzed. The analysis was based on the research questions and hypotheses. Data relating to the research questions were analyzed using mean and standard deviation. The hypotheses were tested at 0.05 alpha level using Analysis of Covariance (ANCOVA). The decision rule is that when Pvalue was less than or equal to 0.05, the null hypotheses was rejected and whenever Pvalue is greater than 0.05, the null hypotheses was not be rejected.

III. Results

Research Question 1: What is the difference in the mean achievement scores of students taught chemistry with think-pair-share strategy and those taught with conventional method (CM)?

Table 1: Mean Achievement Scores of Students Taught Chemistry Using TPS Learning Strategy and those taught Using Conventional Method

Group	N	Pretest Mean	Posttest Mean	Gained Mean	Pretest SD	Posttest SD
TPS	60	20.33	80.80	60.47	9.11	3.85
CM	61	18.20	50.25	32.05	8.99	5.20

Table 1 reveals that the students taught chemistry using TPS learning strategy has pretest mean achievement score of 20.33 and posttest mean achievement score of 80.80 with gained mean achievement score of 60.47, while those in the control group taught with conventional method has pretest mean score of 18.20 and posttest mean score of 50.25 with gained mean 32.05. The use of TPS reduced the variation of score from 9.11 in the pretest to 3.85 in the posttest. There was a low score variation in the posttest of the TPS group (3.85) compared to those taught using conventional method (5.20).

Research Question 2: What is the difference in the mean achievement scores of male and female students taught chemistry with think-pair-share strategy?

Table 2: Mean Achievement Scores of Male and Female Students taught Chemistry using TPS Learning Strategy

Gender	N	Pretest Mean	Posttest Mean	Gained Mean	Pretest SD	Posttest SD
Male	23	22.61	81.22	58.61	10.43	4.671
Female	37	18.92	80.54	61.62	8.00	3.288

Table 2 reveals that the male students taught chemistry using TPS learning strategy has pretest mean achievement score of 22.61 and posttest mean achievement score of 81.22 with gained mean achievement score of 58.61, while those in the control group taught with conventional method has pretest mean score of 18.92 and posttest mean score of 80.54 with gained mean 61.62. The use of TPS reduced the variation of score among females more than among males.

Hypothesis 1: There is no significant difference in the mean achievement scores of students taught chemistry with think-pair-share (TPS) learning strategy and those taught with conventional method.

Table 3: ANCOVA Test of Significant Difference in Mean Achievement Scores of Students taught Chemistry using TPS and Conventional Method

Source of variation	SS	Df	MS	F	P-value	Decision
Corrected Model	28244.010[a]	2	14122.005	668.981	.000	
Intercept	91283.632	1	91283.632	4324.243	.000	
Pretest	5.963	1	5.963	.282	.596	
Method	27747.267	1	27747.267	1314.430	.000	S
Error	2490.949	118	21.110			
Total	548219.000	121				
Corrected Total	30734.959	120				

Table 3 shows that at 0.05 level of significance, 1df numerator and 120df denominator, the calculated F is 1314.430 with Pvalue of .000 which is less than 0.05. Therefore, the null hypothesis was rejected. Thus, there is a significant difference in the mean achievement scores of students taught chemistry with think-pair-share (TPS) learning strategy and those taught with conventional method.

Hypothesis 2: There is no significant difference in the mean achievement scores of male and female students taught chemistry with think-pair-share strategy.

Table 4: ANCOVA Test of Significant Difference between the Mean Achievement Scores of Male and Female Students taught Chemistry using TPS Learning Strategy

Source of variation	SS	Df	MS	F	P-value	Decision
Corrected Model	26.105[a]	2	13.053	.876	.422	
Intercept	57851.994	1	57851.994	3881.794	.000	
Pretest	19.607	1	19.607	1.316	.256	
Gender	2.620	1	2.620	.176	.677	NS
Error	849.495	57	14.903			
Total	392594.000	60				
Corrected Total	875.600	59				

Table 4 shows that at 0.05 level of significance, 1df numerator and 59df denominator, the calculated F is .176 with Pvalue of .677 which is greater than 0.05. Therefore, the null hypothesis was not rejected. Thus, there is no significant difference in the mean achievement scores of male and female students taught chemistry with think-pair-share strategy.

Hypothesis 3: There is no significant interaction effect of teaching methods and gender on students' achievement in chemistry.

Table 5: ANCOVA Test of Interaction Effect of Teaching Methods and Gender on Students' Achievement in Chemistry

Source of variation	SS	Df	MS	F	P-value	Decision
Corrected Model	28498.439[a]	4	7124.610	369.527	.000	
Intercept	87309.098	1	87309.098	4528.400	.000	
Pretest	1.062	1	1.062	.055	.815	
Method	27184.347	1	27184.347	1409.952	.000	
Gender	163.014	1	163.014	8.455	.004	
Method * Gender	85.664	1	85.664	4.443	.067	NS
Error	2236.519	116	19.280			
Total	548219.000	121				
Corrected Total	30734.959	120				

Table 5 further shows that at 0.05 level of significance, 1df numerator and 120df denominator, the calculated F is 4.443 with Pvalue of .067 which is greater than 0.05. Therefore, the null hypothesis was not rejected. Thus, there is no significant interaction effect of teaching methods and gender on students' achievement in chemistry.

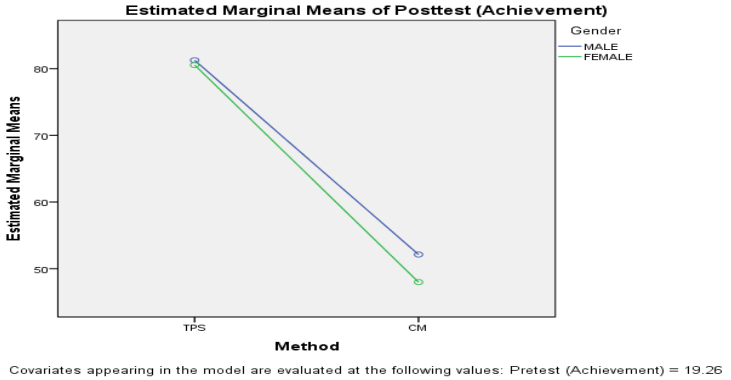

Figure 1: Plot of interaction effect of teaching methods and gender on students' achievement in chemistry.

IV. Discussion

The finding of the study showed that there was significant difference in the mean achievement of students taught using think-pair-share strategy and those taught using conventional method in favour of think-pair-share strategy. The observed result is because think-pair-share strategy afforded the students opportunity to interact extensively over the learning material. Thus, students who could not understand some aspect of the material on their own, asked and inquired from their peers during the pairing. Also, students shared with the larger class in the likeness of a teacher thereby concretizing what they have learnt.

Students' ability to understand the material during the thinking time also helped them to develop skills of scientific thought and may have increased their scientific literacy. Have read, understood and sought assistance, students developed a study pattern that proved effective and therefore had the motivation to further study other materials even on their own and with their pairs. The extra studies facilitated meaningful and deeper learning of the materials and its contents resulting in increased academic achievement.

The findings of the study is in line with that of Furquon (2015) that there was a significant difference in reading comprehension achievement between the students who were taught by using think-pair-share model and those who were taught by using teacher-centred method. The findings of the study also support that of Marvin (2015) that there was significant difference in the posttest academic performance mean scores between the experimental groups (Co Op-Co Op), (Think-Pair-Share) and control group (traditional method). The findings of the study is also in line with that of Andrew and Alexandria (2015) that students' learning outcomes improved significantly from this strategy of think-pair-share. The findings also support that of Adekunle (2015) that students taught with guided discovery and think-pair-share strategies obtained significantly higher posttest mean scores than those in the lecture strategy.

The finding of the study also revealed that there was no significant difference between the mean achievement scores of male and female students in chemistry. There was also no significant interaction effect of teaching methods and gender on students' achievement in chemistry. These findings of the study is because think-pair-share strategy equally affected the students' learning thereby ensuring that both male and female students' achievement were improved. The finding of the study is in contrast to the findings of Ribhi (2017) that female students taught using think-pair-share strategy significantly performed better than their male counterparts. The findings also contravenes the findings of Nwaubani, Ogbueghu, Adeniyi, and Eze (2016) that Think-Pair Share (TPS) and Student Teams-Achievement Division (STAD) significantly improved students' achievement in economics with female students achieving better than their male counterparts.

V. Conclusion

The conclusion drawn from the findings is that think-pair-share strategy is an effective strategy for the teaching and learning of chemistry concept. The strategy also makes the learning of chemistry more engaging for students. It can also be concluded that when chemistry teachers adopted think-pair-share teaching strategy, student to student interaction increases making students to take responsibility for their learning.

VI. Recommendations

In line with the findings of this study, the following recommendations are made:

1. Chemistry teachers should adopt the use of think-pair-share strategy in the teaching and learning of chemistry in order to ensure meaningful learning.
2. Workshops and seminars should be organized by school heads to orient chemistry teachers on how to effectively use think-pair-share strategy in the teaching and learning of chemistry.

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