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ENHANCING SECONDARY SCHOOL STUDENTS' CHEMISTRY PERFORMANCE THROUGH THINK–PAIR–SHARE COOPERATIVE LEARNING: A QUASI-EXPERIMENTAL STUDY FROM BENUE STATE, NIGERIA

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Abstract
This study on effect of think-pair-share strategy on academic performance of senior secondary ii students in chemistry in Benue State was guided by three research questions and three corresponding hypotheses. It employed Quasi-experimental design of non-randomized pre-test, post-test control group design. Population consisted of 1,960 (1,105 male and 855 female) Senior Secondary II (SS2) students in 183 in schools. A sample of 86 (46 male and 40 female) SS II students offering Chemistry in two intact classes were obtained using purposive and simple random sampling techniques. Chemistry Performance Test (CPT) was developed by the researchers for data collection. Face and content validation of CPT was done by three experts and yielded a reliability coefficient of 0.84. Data collection was done by the researchers, aided by research assistants teaching Chemistry. Research questions were answered using mean and standard deviation while hypotheses were tested with Analysis of Co-variance at 0.05 alpha levels. It was found that: significant difference exists in performance of students taught Chemistry using Think-Pair-Share strategy ($F(1, 83) = 268.308$; $p = 0.000 < 0.05$). However, no significant difference exists between the performance of male and female students taught Chemistry using TPS strategy ($F(1, 42) = 0.381$; $p = 0.541 > 0.05$). *It was concluded that TPS strategy is capable of enhancing the academic performance of students in Chemistry, irrespective of gender. Based on findings, it was recommended among others that Chemistry teachers should use TPS strategy to enhance teaching and learning to enhance students' performance in Chemistry.*

Keywords: Think-Pair-Share (TPS), Academic Performance, Chemistry Education, Students' Gender and Secondary Education.

Introduction

Chemistry is a core subject in the senior secondary school curriculum that plays a significant role in shaping the scientific understanding of students. It is essential in equipping students with the knowledge required for higher education in fields such as medicine, engineering, and environmental sciences among others (Ababio, 2024). Chemistry, as a subject, forms the foundation of understanding scientific phenomena that are essential in daily life. Chemistry is recognized globally as it has applications in numerous

disciplines, such as pharmaceuticals, agriculture, and technology (Bajah, 2019). Senior secondary school chemistry is designed to equip students with the requisite knowledge and skills necessary for pursuing higher education in scientific fields.

In spite of the benefits derive from Chemistry to the society, the performance of candidates in School Certificate Chemistry over the years have not been encouraging in external examination (WAEC 2018 - 2024). In Benue State, the performance of students in this subject has been consistently low, with many students expressing difficulty in understanding key concepts such as chemical bonding, stoichiometry, and thermodynamics. Moreover, the widespread discouraging academic performance at this level could lead to decline enrollment in science-based courses in higher education. Furthermore, the expected progress and breakthrough in science and technology may not be attained; hence, the outcome would be lack of economic growth, lack of job creation and decline in the quality of life which will adversely affect national development.

This academic underperformance has been attributed to several factors, including the traditional teaching methods, the lack of student engagement, and insufficient interaction during lessons leading to passive learning and lower academic performance (Abdullahi, 2018). The traditional methods of teaching in Nigerian secondary schools, particularly in Benue State, often do not fully harness the potential of students. These methods, which rely heavily on rote memorization and teacher-centered instruction, frequently fail to engage students meaningfully with the learning content. In chemistry, where abstract concepts such as atomic structure, bonding, and chemical reactions are prevalent, students are often left with an incomplete understanding of these topics. Without the opportunity to engage in hands-on activities or discussions that clarify these concepts, students may develop misconceptions or fail to make meaningful connections with the material. As a result, academic performance in chemistry remains suboptimal, leading to a significant gap between expected and actual learning outcomes.

In response to the challenges associated with teaching and learning chemistry, Think-Pair-Share (TPS) has emerged as a potential cooperative learning strategy for enhancing students' engagement, understanding and academic performance. Such engagements help students to brainstorm and understand what they learn (Otor et al., 2024; Kpiranyam et al., 2024). TPS involves three sequential stages: students first think independently about a question or problem, then discuss their ideas with a partner, and finally share their responses with the wider class (Achimugu, 2017). This structure promotes active participation, peer interaction and collaborative knowledge construction.

As a simple yet effective cooperative learning strategy, TPS provides students with opportunities to process information individually, learn from their peers, articulate ideas and receive feedback through discussion. These processes may improve information recall, communication, self-confidence and understanding of complex chemistry concepts (Akanmu, 2019). The strategy also encourages students to become more active and socially engaged in the learning process, thereby fostering cooperation and interest in the subject (Napitupulu & Surya, 2017). Furthermore, TPS can promote critical thinking and problem-solving skills, which are essential for understanding the analytical and problem-solving nature of chemistry (Abdurrahman, 2019). Consequently, its emphasis on individual reflection, peer discussion and whole-class sharing makes

TPS a promising instructional approach for improving students' learning outcomes in chemistry (Kurnaisih, 2017).

Academic performance, in the context of this study, refers to the extent to which a student demonstrates mastery of subject content, skills, and competencies expected at a given level of instruction (Uche, 2022). It is commonly assessed using objective indicators such as test scores, examination results, grades, and overall academic performance. Beyond these measures, academic performance of male and female students is viewed as a multidimensional construct that encompasses the cognitive, affective, and psychomotor domains of learning (Adonu, *et al.*, 2021).

Gender is a socially ascribed attribute, which differentiates feminine from masculine. Enemarie and Kpiranyam (2025) have reported the influence of gender on Chemistry performance of students. This had led to divergent views on the influence of gender on the students' performance in Chemistry (Oliweh, et al., 2021). While some studies indicated that there is no statistically significant difference in the students' performance in Chemistry based on gender (Iheonunekwu, 2016). Some studies revealed that males performed better than their female counterparts in Chemistry (Bamiro, 2015; Moyegun & Oluwasegun, 2022). While Ganley and Lubienski (2016) were of the view that these differences could be as a result of female students being a 'good girl' in school by doing strictly only the things the class teacher asks them to do. Hence, they do not try out other creative or risky things that could enhance their problem-solving skills in Chemistry. Against the backup of the controversial nature of the findings, additional research on gender difference in other to have more comprehensive empirical evidence on gender and students' performance in Chemistry. Therefore, this study investigated effect of Think-Pair-Share on Students' Academic Performances in Chemistry.

Statement of the Problem

Different teaching and learning approaches are still open for investigation in Chemistry all over the world and mostly among secondary schools in Nigeria. Due to students' low performance as a result of poor pedagogical choices, the academic results of students in senior school Certificate Examination and Joint Admission and Matriculation Board examinations are unsatisfactory. The WAEC Chief Examiners' Report WAEC (2014 – 2022) stated that some of the reasons for students' poor academic performance in chemistry may have caused continuous decline in students' academic performance in chemistry. This is a situation that will adversely affects their future academic and career prospects in Chemistry related fields if not abated. Despite the availability of well-structured curricula and qualified teachers, students (Male and Female) continue to struggle with the conceptualization and application of key chemical principles. This poor performance has been attributed to factors such as inadequate teaching methods, lack of active student participation, and insufficient opportunities for collaborative learning (Abdullahi, 2018). In many classrooms, teachers dominate the lesson delivery process, leaving students as passive recipients of information. Due to poor academic performance occasioned by poor teaching methods in chemistry and limited research in this area, this study bid to examine if Think-Pair-Share strategy (TPS)

could have the potential to improve academic performance in Chemistry in Benue State, Nigeria.

Research Questions

The following research questions guided this study:

1. What is the difference between mean academic performance scores of students taught Chemistry using Think-Pair-Share and those taught using conventional strategy?
2. What is the effect of Think-Pair-Share (TPS) strategy on male and female students' academic performance in Chemistry?
3. What is the interaction effect of strategies and gender on students' academic performance in Chemistry?

Hypotheses

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

1. There is no significant difference in mean academic performance scores of students taught Chemistry using Think-Pair-Share and those taught using conventional strategy.
2. There is no significant effect of Think-Pair-Share (TPS) strategy on male and female students' academic performance in Chemistry.
3. There is no significant interaction effect of strategies and gender on students' academic performance in Chemistry.

Method

The design for this study was quasi-experimental design, that is, a non-randomized pre-test, post-test control group design. According to Emaikwu (2018) and Agogo and Achor (2019), when it is not possible to randomly sample and assign subjects to groups, the researcher can use inter classes. The quasi-experimental design is appropriate because existing chemistry classes cannot be reorganised without disrupting normal school programmes; hence, intact classes will be used.

The population consisted of 1,960 (1,105 male and 855 female) Senior Secondary II (SS2) students offering Chemistry in 183 government public senior secondary schools in Benue State in the 2023/2024 academic session (Source: Benue State Teaching Service Board, Makurdi, 2024). The sample Comprised 86 (46 male and 40 female) SSII students offering Chemistry in two government established schools in Makurdi Local Government Area of Benue State. The sample was drawn using purposive and simple random sampling. Purposive sampling was used to select three schools each from within Makurdi. The reason for purposive sampling is to ensure that only schools with qualified Chemistry teachers (at least BSc Ed Chemistry) and only co-educational secondary schools were selected because of the gender variable in the study. Out of the two schools, one each was randomly assigned to experimental group while the second school was the control group. The researcher further used simple random sampling to select one intact class from each of the two schools for the various groups.

Chemistry Performance Test assessed students' ability to apply their knowledge of chemistry through practical tasks and activities. It focuses on the direct observation of students' performance in chemistry-related exercises, measuring how effectively they execute specific procedures and apply concepts in real-life practical situations. The Chemistry Performance Test (CPT) was developed from selected topics, including the Periodic Table, stoichiometry, chemical reactions, and quantitative and volumetric analysis. It was divided into two sections: Section A contains students' bio

data, while Section B initially consisted of 40 multiple-choice questions with four options. Following psychometric analysis, the number of items was reduced to 30. The questions were distributed across the selected topics in alignment with the lesson objectives, outlined in the table of specification.

To ascertain the reliability of the instruments, the CPT was trial tested on 30 students. Each instrument was filled and returned. The reliability of CPT was computed using Kuder Richardson formula (KR-20). It yielded a reliability coefficient 0.84. The obtained value exceeds the minimum acceptable threshold of 0.50. According to Emaikwu (2018), this indicates that the instrument is reliable. The research questions were answered using mean and standard deviation while Analysis of Covariance (ANCOVA) was used to test the stated hypothesis at 0.05 level of significance.

Results

The results are presented in accordance with the sequence of research questions alongside the respective hypotheses. Research Questions One is answered in Table 1. Research Questions Two is answered in Table 2. Research Questions Three is answered in Figure 1. On the other hand, hypotheses 1, 2 and 3 are tested in Table 3, 4 and 5.

Table 1: Mean and Standard Deviation of Performance Score of Students Taught Chemistry using the Think-Pair-Share (TPS) Strategy and those Taught using Conventional Strategy

Group	**n**	**Pre-test**		**Post-test**		**Mean gain**
		Mean	**Std. D.**	**Mean**	**Std. D.**	
TPS	45	25.53	6.20	65.73	6.63	**40.20**
Conventional Strategy	41	23.66	4.37	38.32	8.46	**14.66**
Mean Difference Total	**86**	**1.87**		**27.41**		**25.54**

Table 1 presents that the mean academic performance scores of students taught Chemistry using TPS strategy was 25.53 with standard deviation of 6.20 at pre-test. It also shows mean academic performance scores of 65.73 with standard deviation of 6.63 at the post-test. The mean academic performance scores of students taught Chemistry using Conventional strategy was 23.66 with standard deviation of 4.37 during pre-test. It also shows mean academic performance scores of 38.32 with standard deviation of 8.46 at the post-test. Table 2 also shows that the mean gain academic performance of students taught Chemistry using TPS strategy was 40.20, while those taught using Conventional strategy had a mean gain academic performance of 14.66. The mean academic performance between the two groups was 25.54 in favour of students who taught Chemistry using TPS strategy.

Table 2: Mean and Standard Deviation of Performance Score of Male and Female Students Taught Chemistry using the Think-Pair-Share (TPS) strategy

Group	n	Pretest		Post-test		Mean gain
		Mean	Std. D.	Mean	Std. D.	
Male	24	24.87	6.02	65.04	7.28	**40.17**
Female	21	26.29	6.47	66.52	5.88	**40.23**
Mean Difference	**45**	**1.42**		**1.48**		**0.06**
Total						

Table 2 revealed that male students taught Chemistry using Think-Pair-Share (TPS) strategy had a mean academic performance score of 24.87 with standard deviation of 6.02 in the Pre- test and mean academic performance scores of 65.04 and standard deviation of 7.28 in the post-test. Female students who taught Chemistry using Think-Pair-Share (TPS) strategy had a mean academic performance score of 26.29 with standard deviation of 6.47 in the Pre-test and mean academic performance scores of 66.52 and standard deviation of 5.88 in the Post-test. The table also showed that male students taught Chemistry using TPS strategy had a mean gain of 40.17. While that of female students taught using TPS strategy had a mean gain of 40.23 with a small mean gain difference of 0.06 in favour of female students taught using TPS strategy.

Figure 1: Interaction Effect of Strategies and Gender on Students' Performance in Chemistry

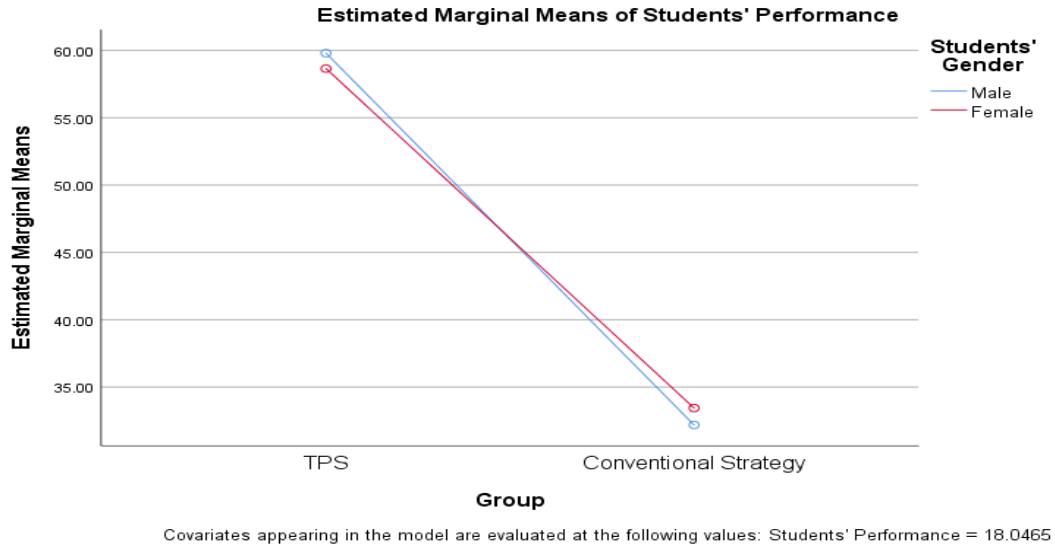

Figure 3 shows the profile plot of the interaction effect of teaching strategies and gender on students' performance. The interaction pattern shows that the plots for male and female students do not intersect, although they are close under both TPS and the conventional strategy. This suggests that there is no apparent interaction effect of teaching strategies and gender on students' performance.

Table 3: ANCOVA Summary of Performance Scores of Students taught Chemistry using Think-Pair-Share and those Taught using Conventional Strategy.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	16172.559[a]	2	8086.279	141.337	.000	.773
Intercept	9165.810	1	9165.810	160.206	.000	.659
Pretest	47.016	1	47.016	.822	.367	.010
Strategy	**15350.646**	**1**	**15350.646**	**268.308**	**.000**	**.764**
Error	4748.662	83	57.213			
Total	259431.000	86				
Corrected Total	20921.221	85				

Table 3 indicates that F (1, 83) = 268.308; p = 0.000 < 0.05. Thus, the null hypothesis was rejected. This means that there was a significant difference between the mean academic performance of students taught Chemistry using Think-Pair-Share and those taught using conventional strategy. The partial eta squared vale of 0.764 is considered a large effect size, indicating that the TPS has a substantial impact on students' performance in Chemistry. This means that approximately, 76.4% of the variance in students' performance scores in Chemistry can be attributed to the difference between the two teaching methods and also, there is a strong association between TPS.

Table 4: ANCOVA Summary of Think-Pair-Share (TPS) Strategy on Male and Female Students' Academic Performance in Chemistry.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	75.976[a]	2	37.988	.858	.431	.039
Intercept	9077.159	1	9077.159	205.098	.000	.830
Pretest	51.372	1	51.372	1.161	.287	.027
Gender TPS	**16.852**	**1**	**16.852**	**.381**	**.541**	**.009**
Error	1858.824	42	44.258			
Total	196374.000	45				
Corrected Total	1934.800	44				

Table 4 indicates that F (1, 42) = 0.381; p = 0.541 > 0.05. Hence, null hypothesis was not rejected. This means that there was no significant difference between the mean academic performance of male and female students taught Chemistry using TPS strategy. The partial eta squared vale of 0.009 is considered a small effect size, indicating that male and female students perform similarly in Chemistry performance when taught using TPS and PTS in Chemistry. This means that approximately, 0.9% of the variance in students' performance scores in Chemistry can be attributed to no statistically significant difference between male and female.

Table 5: ANCOVA Summary of Strategies and Gender on Students' Performance in Chemistry

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	45087.336[a]	4	11271.834	815.923	.000
Intercept	259.749	1	259.749	18.802	.000
Prete	2083.014	1	2083.014	150.781	.000
Grp	3395.351	1	3395.351	245.776	.000
Gen	.065	1	.065	.005	.946
Grp * Gen	30.577	1	30.577	2.213	.141
Error	1119.001	81	13.815		
Total	233091.000	86			
Corrected Total	46206.337	85			

a. R Squared = .976 (Adjusted R Squared = .975)

Table 5 shows that the interaction between teaching strategy and gender was not statistically significant, F (1, 81) = 2.213; p = 0.141 > 0.05. Since p > 0.05, the null hypothesis was not rejected. This means that the effectiveness of the teaching strategies did not significantly depend on students' gender. In other words, the strategies did not produce significantly different effects for male and female students. The R^2 value of .976 (Adjusted R^2 = .975) indicates that the model explains approximately 97.6% of the variance in students' Chemistry performance, reflecting a very strong explanatory power.

Discussion of Findings

This study examined the effects of the Think-Pair-Share strategy (TPS) on the academic performance of Senior Secondary School SS 2 students in Chemistry in Benue State. This study found that, there was a significant mean difference between the mean academic performance of students taught using Think-Pair-Share (TPS) strategy and those taught using Peer Tutoring Strategy. This finding agrees with the finding of Apeh and Agogo (2024) which reveals that think-pair-share learning strategy significantly increases students' performance in chemistry more than the conventional (Demonstration Method) of teaching. The finding supports with Moyegun and Oluwasegun (2022) who found that think-pair-share learning strategy significantly increases students' performance in chemistry more than the conventional method (Demonstration Method) of teaching. This finding corroborates the findings of Usang and Okoli (2022) who found that there was significant difference in the mean performance scores of the students taught using think-pair-share and those taught using conventional method. Also, finding is consistent with the findings of Akanmu (2019) whose findings shows a statistically significant difference in the performance of students taught set theory using think-pair-share compared with their counterparts in the control group in favor of think-pair-share group. This study further validates the findings of Parker and Asare (2020) that think-pair-share learning technique of teaching motivate and engage, provide immediate feedback, develop social, and physical skills simultaneously, help students to learn with fun and increase students interest and confidence level. The findings of this study is consistent with other findings possibly because maybe it was carried in the condition though at various locations, cultural differences and others.

The finding that gender does not significantly impact academic performance when using the Think-Pair-Share (TPS) strategy represents a critical pivot point in STEM education research. The consistency of this result with the work of Akanmu (2019) and Okekeokosisi and Okigbo (2019) suggests that TPS possesses an inherent "structural equity" that conventional methods lack. This finding agrees with that of Gambari and Yusuf (2014) whose findings indicated significant no significant difference in the performance between male and female when taught using peer tutoring. These findings corroborate that of Molla and Muche (2018) that there was gender parity regarding Performance of male and female students using peer tutoring strategy. This finding also corroborates the findings of Yaduvanshi and Singh (2018) that implementation of peer tutoring strategy fosters academic performance of both male and female students. This could be attributed to the ability of the strategy to engender free discussion and sharing of ideas among students while learning Chemistry.

This result further shows the interaction between strategy and gender on academic performance was not statistically significant. This result is consistent with Okekeokosisi and Okigbo (2019), who reported that there was no significant interaction effect of gender and teaching methods on students' mean performance and interest scores in Computer Studies. This suggests that the effectiveness of the instructional strategy on students' academic performance was not significantly influenced by gender, as both male and female students benefited similarly from the instructional strategies employed. This result does not concord with Okekeokosisi and Okigbo (2019) that there was interaction effect of gender and teaching methods on mean performance and interest scores of students in computer studies. The implication from this finding is that the instructional strategies are equally effective for both male and female students and can be used in mixed-gender classrooms.

Conclusion

The findings of this study lead to the conclusions that TPS strategy is capable of enhancing the academic performance of students in Chemistry. Furthermore, the findings in this study revealed that TPS strategy are efficacious in eliminating gender related differences in performance of Chemistry students, indicating that the approach is gender friendly.

Recommendations

Based on findings of this study, the following recommendations were outlined:

I. Chemistry teachers should use TPS strategy to ensure effective teaching and learning to enhance students' performance in Chemistry.
II. Teachers should encourage male and female students during teaching and learning with TPS strategy enhance their academic performance equally.
III. Workshops should be frequently organized by educational bodies such as National Teachers Institute (NTI) to sensitized Chemistry teachers and other educators on the use of TPS strategy to enhance performance among senior secondary students.

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