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EFFECTS OF TIMED THINK-PAIR-SHARE AND CIRCLE CHAT ON STUDENTS' ACADEMIC ACHIEVEMENT IN BASIC CHEMISTRY CONCEPTS

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Abstract: **The study examined the effects of Timed Think-Pair-Share (TTPS), Timed Circle Chat (TCC) and Conventional Lecture Method (CLM) on chemistry students' achievement in Basic Chemistry Concepts. Quasi-experimental design of 3 x 3 x 2 factorial matrix. Two hundred and twenty-one public senior secondary school class two students were sampled for the study from twelve schools in Oyo Zone, Oyo State, Nigeria. The schools were grouped into the TTPS, TCC and CLM groups. The research instruments were Mathematical Ability Test (MAT), Achievement Test in Basic Chemistry Concepts (ATBCC) and Learning Package for Basic Chemistry Concepts (LPBCC) for the treatment. The instruments were validated and were pilot tested to determine their reliabilities using Kuder-Richardson 20 (KR-20) for ATBCC and MAT and Scott's Pie (π) for LPBCC. The chemistry teachers in the sampled schools were trained on the learning strategy that was randomly assigned to each school. The chemistry teachers facilitated the students in the learning strategies for six weeks. The MAT and ATBCC were pre-administered to the sampled students. The students' scores on MAT was used to classify the students in mathematical ability levels. The ATBCC was post-administered to the students after the treatment. The data collected were analysed using Analysis of Covariance (ANCOVA). The results show significant main effects of the treatment in favour of TTPS, followed by TCC and CLM. There were significant main effects of gender, in favour of female students, and mathematical ability in favour of the students with high mathematical ability on students' achievement.**

Keywords: **Achievement in Basic Chemistry Concept, Conventional Lecture Method (CLM), Mathematical Ability Test (MAT), Students' Gender (SG), Timed Circle Chat (TCC), Timed Think-Pair-Share (TTPS).**

I. INTRODUCTION

Constructivist learning theories emphasis students' active construction of knowledge from the learning environment and participating actively in the process of teaching and learning.as against the traditional lecture method of teaching. Social constructivist theory opined that that knowledge is socially constructed via students' discussion of constructed knowledge from the learning environment. The teachers' role is to facilitate learning by providing an enriched learning environment, probing into students' conceptions, enhancing right conception and eliminating the misconception in the teaching and learning process.

Think-Pair-Share and Circle Chat are pedagogical learning strategies that were born out of search to increase students' participation in class lessons. Think-Pair-Share (TPS) and Circle Chat are active collaborative learning strategies where

students socially interact to foster meanings of concepts and eliminate misconceptions. The Think-Pair-Share involves three stages of thinking, pairing and share as in the name. That is, the students think on a given problem or activity, pair with the counterparts to share their responses on the problem or activity with their counterparts.

The Circle Chat is similar to Think-Pair-Share except that in Circle Chat learning strategy, the level of interaction of the students in sharing information or responses with their counterparts is greater than that of the Think-Pair-Share learning strategy. In Circle Chat learning strategy, the students are arranged into two concentric circles of inner and outer circle with the same number of students in each circle.

[6] found that Think-Pair-Share learning strategies enhanced students' performance and motivation in chemistry. [2] and [12]'s findings on the effects of Think-Pair-Share showed that senior secondary school students taught using Think-Pair-Share strategy performed significantly better than those taught using convectional method and that the students in Think-Pair-Share had better interest in chemistry than their counterparts in the conventional method. The study indicated no interaction effect of treatment and gender on the students' achievement and interest in chemistry. However, [4] showed that Jigsaw instructional strategy to have more significant effect of students' knowledge of carbohydrate in chemistry than Think-Pair-Share and cooperative learning strategies. The study found no significant effect of gender on knowledge retention and there was no interaction effect of treatment and gender in chemistry. [11] found Think and Pair before Share to increase students' collaboration and active class participation in teaching and learning.

[7] investigated Inside-Outside Circle instructional strategy with image media to enhance children language skills and found that the strategy positively influenced the pupils' language skills. [10] examined the effect of Inside-Outside Circle on primary school pupils' academic achievement in mathematics and showed a significant effect of treatment on the pupils' achievement in mathematics. However, the study showed that gender of the pupils had no effect on the achievement. There was also no interaction effect of the treatment and gender on the achievement. [5] found no significant effect of treatment with circle the stage instructional strategy on numerical ability of students in physics. The students also revealed no gender effect and its interaction effect with treatment on students' numerical ability in the subject. [3] found a significant difference between the creative thinking skill of the male and female in differentiated science inquiry in favour male. The study showed no significant interaction of the teaching method and gender on the students' creative thinking skill.

[1]'s findings indicated a significant positive correlation of the students' performance in mathematics and chemistry. [13] showed content relationship between the chemistry and mathematics curricula in the Nigerian Senior Secondary Schools and found significant relationships between the achievement in chemistry and mathematics and their chemistry teachers mathematical background. [14] investigated the effects of conceptual understanding of mathematics principles on academic achievement of secondary chemistry students and found that teaching of relevant mathematics principles to chemistry students facilitate the students' academic achievement in chemistry. [9] and [8] indicated signification effects of inquiry-based learning instruction on chemistry students' computational and conceptual knowledge, respectively.

II. STATEMENT OF THE PROBLEM

Secondary school education is a foundation for building students for science careers and the related profession. The teaching of science in the level of education is imperative for developing in students the skills, knowledge and attitude to excel as future scientists. The average performance in chemistry reported by [15] for past six years was predominately due to non-adhere of chemistry instructions to promote active involvements of the students as advocated by constructivists learning theories but, the teachers sticking to the traditional methods of teachings like teacher demonstration and lecture method. This study aimed at investigating the effect timed think-pair-share and circle chat as instructional strategies on students' achievement in chemistry. The learning strategies were limited in the teaching of chemistry especially with Circle Chat and Think-Pair-Share had been greatly explored mostly in English and Mathematics.

III. HYPOTHESES

The hypotheses formulated for the study are:

The following null hypotheses were formulated for the study.

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1. There is no significant main effect of treatment on students' achievement in Basic Chemistry concepts in secondary schools in the Oyo Zone of Oyo State.

2. There is no significant main effect of gender on students' achievement in Basic Chemistry concepts in secondary schools in the Oyo Zone of Oyo State.

3. There is no significant main effect of mathematical ability on students' achievement in Basic Chemistry concepts in secondary schools in Oyo Zone of Oyo State.

4. There is no significant interaction effect of treatment and gender on students' achievement in Basic Chemistry concepts in secondary schools in Oyo Zone of Oyo State.

5. There is no significant interaction effect of treatment and mathematical ability on students' achievement in Basic Chemistry concepts in secondary schools in Oyo Zone of Oyo State.

6. There is no significant interaction effect of gender and mathematical ability on students' achievement in Basic Chemistry concepts in secondary schools in Oyo Zone of Oyo State.

7. There is no significant interaction effect of treatment, gender and mathematical ability on students' achievement in Basic Chemistry concepts in secondary schools in Oyo Zone of Oyo State.

IV. METHODOLOGY

Quasi experimental of 3 x 3 x 2 factorial design was the research design. Senior secondary school chemistry students in class two in Oyo Educational Zone was the population. Twelve schools where randomly drawn from the population. Four hundred and twenty-one (421) students were the samples consisted of one hundred ninety-four (194) male students and two hundred twenty-seven (227) female students. The schools were randomly assigned to the three learning groups designated as TTPS, TCC and CLM. The TTPS group had 155 participants, the participants in the TCC group were 123 while CLM group had 143 participants.

The researcher trained the chemistry teachers in the sampled schools on the learning strategies using LPBCC. The teachers attained proficiency on the LPBCC before they facilitated the students in the learning of Basic Chemistry concepts for six weeks. The Basic Chemistry concepts were on mixture and compound, physical and chemical processes, atom, relative atomic mass and chemical formulae and calculations related to some of the concepts.

The procedural steps for TTPS are:

Step 1: Grouping of the students into six (6) members of mixed ability by the chemistry teacher.

Step 2: Students in the group carry out the activity in the instructional package.

step 3: Students first think about the activity / problem

Step 4: Individual students write down their findings / results.

Step 5: The student pair with another student sitting near him /her to share their findings / results

Step 6: The teacher asks some students (volunteers) to discuss their findings / results with the whole class.

Step 7: The teacher modifies their discussions.

Each procedural step was timed.

The procedural steps for TCC are:

Step 1: Grouping of the students into inside and outside circles of three (3) members of mixed ability in each circle.

Step 2: The students in the inside circle were labelled A, B and C while the students in the outside circle were labelled 1, 2 and 3.

Step 3: Both the inside and outside circles students separately carry out the activity in the instructional package.

Step 4: Individual students write down their findings / results.

Step 5: The students in outside circle share their findings / results with themselves and then with those the inside circle. The inside circle students were stationary while each member of the outside circle students moved and shared their findings with the inside circle students until each member has interacted with all the members in the inside circle.

Step 6: The teacher asks some of the students (volunteers) to discuss their findings with the whole class.

Step 7: The teacher modified their discussion.

Each procedural step was timed.

The students in the control group were taught theoretically.

There are three major research instruments; the Learning Package in Basic Chemistry Concepts (LPBCC), was used to engage the students in learning, the Achievement Test in Basic Chemistry Concepts (ATBCC) was to determine students' knowledge on the chemistry concepts. The MAT was used to determine students' knowledge of basic mathematics and the scores of the students in MAT was used to classify them into high mathematical ability (≥70), medium mathematical ability (50 to 69) and low mathematical ability (≤ 50).

V. HYPOTHESES TESTING AND RESULTS

1. There is no significant main effect of treatment on students' achievement in Basic Chemistry concepts in secondary schools in the Oyo Zone of Oyo State.

Table 1: Analysis of Covariance of Main Effect of Treatment on Students' Achievement in Basic Chemistry Concepts

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	281404.795	3	93801.598	1088.871	.000	.887
Intercept	224594.422	1	224594.422	2607.144	.000	.862
Pre-test	3.072	1	3.072	.036	.850	.000
Treatment	279156.831	2	139578.415	1620.258	.000*	.886
Error	35922.787	417	86.146			
Total	2465797.000	421				
Corrected Total	317327.582	420				

Source: Field Survey, 2024

Table 1 shows that there was a significant main effect of treatment on students' achievement in Basic Chemistry concepts in secondary schools in the Oyo zone of Oyo State ($F_{(2,417)} = 1620.258$, $p < 0.05$, $\eta^2=0.886$). The null hypothesis was therefore rejected.

Table 2: Estimated Marginal Means of Treatment on Students' Achievement in Basic Chemistry Concepts

			95% Confidence Interval	
Treatment Group	Mean	Std. Error	Lower Bound	Upper Bound
TTPS	90.294	0.746	88.828	91.760
TCC	89.594	.838	87.946	91.241
CLM	35.380	.778	33.850	36.911

Source: Field Survey, 2024

Table 2 shows that participants exposed to TTPS (treatment group 1) had the highest mean score of 90.294 on students' achievement in basic chemistry concepts in secondary schools in Oyo Zone of Oyo State, followed by TCC (treatment group 2) with a mean score of 89.594, while the CLM group had the least mean score of 35.380.

2. There is no significant main effect of gender on students' achievement in Basic Chemistry concepts in secondary schools in the Oyo Zone of Oyo State.

Table 3: Analysis of Covariance of Main Effect of Gender on Students' Achievement in Basic Chemistry Concepts

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	6826.357	2	3413.178	4.595	0.011	0.022
Intercept	177329.332	1	177329.332	238.723	0.000	0.364
Pre-test	2626.789	1	2626.789	3.536	0.061	0.008
Gender	4578.393	1	4578.393	6.163	0.013	0.015
Error	310501.225	418	742.826			
Total	2465797.000	421				
Corrected Total	317327.582	420				

Source: Field Survey, 2024

Table 3 shows that there was a significant main effect of gender on students' achievement in Basic Chemistry concepts in secondary schools in the Oyo Zone of Oyo State ($F_{(1, 418)} = 6.163$, $p < 0.05$, $\eta^2 = 0.015$). The null hypothesis was therefore rejected.

Table 4: Estimated Marginal Means of Gender on Students' Achievement in Basic Chemistry Concepts

Gender	Mean	Std. Error	95 % Confidence Interval	
			Lower Bound	Upper Bound
Male	67.864	1.959	64.014	71.714
Female	74.491	1.810	70.932	78.049

Source: Field Survey, 2024

Table 4 shows that female participants had a higher mean score (74.491) than their male (67.864) counterparts.

3. There is no significant main effect of mathematical ability on students' achievement in Basic Chemistry concepts in secondary schools in Oyo Zone of Oyo State.

Table 5: Analysis of Covariance of Main Effect of Mathematical Ability on Students' Achievement in Basic Chemistry Concepts

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	244456.839	3	81485.613	466.298	0.000	0.770
Intercept	194392.280	1	194392.280	1112.402	0.000	0.727
Pre-test	197.382	1	197.382	1.130	0.288	0.003
Mathematical Ability	242208.874	2	121104.437	693.015	0.000*	0.769
Error	72870.743	417	174.750			
Total	2465797.000	421				
Corrected Total	317327.582	420				

Source: Field Survey, 2024

Table 5 shows that there was a significant main effect of mathematical ability on students' achievement in Basic Chemistry concepts in secondary schools in Oyo Zone of Oyo State ($F_{(2, 417)} = 693.015$, $p < 0.05$, $\eta^2 = 0.769$). The null hypothesis was therefore rejected.

Table 6: Estimated Marginal Means of Mathematical Ability on Students' Achievement in Basic Chemistry Concepts

Mathematical Ability	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Low	35.443	1.170	33.144	37.743
Medium	80.881	1.402	78.124	83.638
High	89.901	0.928	88.078	91.724

Source: Field Survey, 2024

Table 6 shows that participants with high mathematical ability had the highest mean score (89.901), followed by those with medium ability (80.881), while the participants with low mathematical ability (35.443) had the lowest mean score.

4. There is no significant interaction effect of treatment and mathematical ability on students' achievement in Basic Chemistry concepts in secondary schools in Oyo Zone of Oyo State.

Table 7: Analysis of Covariance of Interaction Effect of Treatment and Gender on Students' Achievement in Basic Chemistry Concepts

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	281451.531	6	46908.588	541.313	0.000	0.887
Intercept	221836.747	1	221836.747	2559.936	0.000	0.861
Pre-test	4.233	1	4.233	0.049	0.825	0.000
Treatment	274303.741	2	137151.871	1582.696	0.000	0.884
Gender	21.927	1	21.927	0.253	0.615	0.001
2-way Interaction						
Treatment * Gender	20.474	2	10.237	0.118	0.889	0.001
Error	35876.051	414	86.657			
Total	2465797.000	421				
Corrected Total	317327.582	420				

Source: Field Survey, 2024

Table 7 shows that there was no significant interaction effect of treatment and gender on students' achievement in Basic Chemistry concepts in secondary schools in the Oyo Zone of Oyo State ($F_{(2, 414)} = 0.118$, $p > 0.05$, $\eta^2 = 0.001$). The null hypothesis was therefore accepted.

Table 8: Estimated Marginal Means Effect of Treatment and Gender on Students' Achievement in Basic Chemistry Concepts

				95% Confidence Interval	
Treatment	Gender	Mean	Std. Error	Lower Bound	Upper Bound
TTPS	Male	90.907	1.138	88.669	93.145
	Female	89.829	0.992	87.878	91.779
TCC	Male	89.628	1.348	86.978	92.278
	Female	89.574	1.075	87.461	91.687
CLM	Male	35.497	1.048	33.437	37.558
	Female	35.232	1.167	32.939	37.525

Source: Field Survey, 2024

Table 8 shows that male participants in the timed think-pair-share group had a higher mean score (90.907) than their female (89.829) counterparts. Table 8 further reveals that male participants in the timed circle chat had a higher mean score (89.628) than their female (89.574) counterparts. In the control group, the male participants had a higher mean score (35.497) than their female (35.232) counterparts.

5. There is no significant interaction effect of treatment and mathematical ability on students' achievement in Basic Chemistry concepts in secondary schools in Oyo Zone of Oyo State.

Table 9: Analysis of Covariance of Interaction Effect of Treatment and Mathematical Ability on Students' Achievement in Basic Chemistry Concepts

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	281534.910	9	31281.657	359.201	0.000	0.887
Intercept	167571.747	1	167571.747	1924.192	0.000	0.824
Pre-test	1.996	1	1.996	0.023	0.880	0.000
Treatment	86509.956	2	43254.978	496.688	0.000	0.707
Mathematical Ability	81.969	2	40.985	0.471	0.625	0.002

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2-way Interaction:						
Treatment *Mathematical Ability	78.300	4	19.575	0.225	0.925	0.002
Error	35792.672	411	87.087			
Total	2465797.000	421				
Corrected Total	317327.582	420				

Source: Field Survey, 2024

Table 9 shows that there was no significant interaction effect of treatment and mathematical ability on students' achievement in Basic Chemistry concepts in secondary schools in Oyo Zone of Oyo State ($F_{(4,411)} = 0.225$, $p > 0.05$, $\eta^2 = 0.002$). The null hypothesis was therefore accepted.

Table 10: Estimated Marginal Means Interaction Effect of Treatment and Mathematical Ability on Students' Achievement in Basic Chemistry Concepts

				95% Confidence Interval	
Treatment	Mathematical Ability	Mean	Std. Error	Lower Bound	Upper Bound
TTPS	Low	88.884	2.953	83.080	94.689
	Medium	90.274	0.798	88.706	91.842
	High	92.392	3.301	85.902	98.881
TCC	Low	86.375	5.395	75.770	96.979
	Medium	89.052	1.241	86.612	91.491
	High	90.234	1.176	87.922	92.546
CLM	Low	35.287	2.952	29.484	41.091
	Medium	35.429	0.871	33.717	37.141
	High	35.138	2.208	30.799	39.478

Source: Field Survey, 2024

Table 10 shows that participants with high mathematical ability in the TTPS group had the highest mean score (92.392), followed by those with medium ability (90.274) and the participants with low ability (88.884), respectively. Table 10 further reveals that participants with high mathematical ability in the TCC treatment group had the highest mean score (90.234), followed by those with medium ability (89.052) and the participants with low ability (86.375) respectively.

In the control group, the participants with medium mathematical ability had the highest mean score (35.429), followed by those with low ability (35.287) and the participants with high ability (35.138) respectively. The overall comparison shows that participants with high mathematical ability in the TTPS treatment group had the highest mean score (92.392), followed by those with medium mathematical ability (90.274), while the participants with high mathematical ability (35.138) in the CLM group had the least score.

6. There is no significant interaction effect of gender and mathematical ability on students' achievement in Basic Chemistry concepts in secondary schools in Oyo Zone of Oyo State.

Table 11: Analysis of Covariance of Interaction Effect of Gender and Mathematical Ability on Students' Achievement in Basic Chemistry Concepts

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	178047.653	6	29674.609	88.206	0.000	0.561
Intercept	188384.770	1	188384.770	559.961	0.000	0.575
Pre-test	514.812	1	514.812	1.530	0.217	0.004
Gender	164.073	1	164.073	0.488	0.485	0.001
Mathematical Ability	169555.374	2	84777.687	251.996	0.000	0.549
2-way Interaction:						
Gender * Mathematical Ability	771.075	2	385.537	1.146	0.319	0.006
Error	139279.929	414	336.425			
Total	2465797.000	421				
Corrected Total	317327.582	420				

Source: Field Survey, 2024

Table 11 shows that there was no significant interaction effect of gender and mathematical ability on students' achievement in Basic Chemistry concepts in secondary schools in the Oyo zone of Oyo State ($F_{(2, 414)} = 1.146$, $p > 0.05$, $\eta^2 = 0.019$). The null hypothesis was therefore accepted.

Table 12: Analysis of Covariance of Interaction Effect of Gender and Mathematical Ability on Students' Achievement in Basic Chemistry Concepts

				95% Confidence Interval	
Gender	Mathematical Ability	Mean	Std. Error	Lower Bound	Upper Bound
Male	Low	86.172	1.996	82.247	90.096
	Medium	38.609	2.192	34.299	42.919
	High	80.904	2.937	75.130	86.678
Female	Low	87.811	1.682	84.506	91.117
	Medium	43.644	2.411	38.904	48.384
	High	78.233	2.598	73.127	83.339

Source: Field Survey, 2024

Table 12 shows that male participants with low mathematical ability had the highest mean score (86.172), followed by those with high ability (80.904) and the participants with medium ability (38.609) respectively. Table 12 further shows that female participants with low mathematical ability had the highest mean score (87.811), followed by those with high ability (78.233) and the participants with medium ability (43.644) respectively. The overall comparison shows that female participants with low mathematical ability had the highest mean score (87.811), followed by male participants with low mathematical ability (87.811), while the male participants with medium mathematical ability (38.609) had the lowest score.

7. There is no significant interaction effect of treatment, gender and mathematical ability on students' achievement in Basic Chemistry concepts in secondary schools in Oyo Zone of Oyo State.

Table 13: Analysis of Covariance of Interaction Effect of Treatment, Gender and Mathematical Ability on Students' Achievement in Basic Chemistry Concepts

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	281838.140	18	15657.674	177.359	0.000	0.888
Intercept	158914.393	1	158914.393	1800.073	0.000	0.817
Pre-test	2.276	1	2.276	0.026	0.873	0.000
Treatment	80093.726	2	40046.863	453.623	0.000	0.693
Gender	60.787	1	60.787	0.689	0.407	0.002
Mathematical Ability	123.614	2	61.807	0.700	0.497	0.003
Treatment*Gender	159.801	2	79.900	0.905	0.405	0.004
Treatment*Mathematical Ability	114.038	4	28.509	0.323	0.863	0.003
Gender*Mathematical Ability	66.038	2	33.019	0.374	0.688	0.002
3-way Interaction: Treatment*Gender* Mathematical Ability	253.182	4	63.296	0.717	0.581	0.007
Error	35489.442	402	88.282			
Total	2465797.000	421				
Corrected Total	317327.582	420				

Source: Field Survey, 2024

Table 13 shows that there was no significant interaction effect of treatment, gender and mathematical ability on students' achievement in Basic Chemistry concepts in secondary schools in the Oyo zone of Oyo State ($F_{(4, 402)} = 0.717$, $p>0.05$, $\eta^2 = 0.007$). The null hypothesis was therefore accepted.

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Table 14: Estimated Marginal Means Interaction Effect of Treatment, Gender and Mathematical Ability on Students' Achievement in Basic Chemistry Concepts

Treatment	Gender	Mathematical Ability	Mean	Std Error	95% Confidence Interval	
					Lower Bound	Upper Bound
TTPS	Male	Low	90.795	1.215	88.406	93.183
		Medium	91.645	5.426	80.977	102.312
		High	91.990	4.698	82.753	101.226
	Female	Low	89.868	1.071	87.763	91.973
		Medium	87.700	3.552	80.716	94.683
		High	92.796	4.707	83.543	102.049
TCC	Male	Low	89.086	2.165	84.829	93.343
		Medium	75.090	9.412	56.586	93.593
		High	90.505	1.776	87.014	93.996
	Female	Low	89.036	1.525	86.037	92.035
		Medium	92.022	6.645	78.958	105.086
		High	90.017	1.590	86.892	93.143
CLM	Male	Low	33.810	3.839	26.264	41.356
		Medium	35.603	1.157	33.329	37.877
		High	35.974	3.555	28.986	42.963
	Female	Low	37.501	4.698	28.265	46.737
		Medium	35.194	1.344	32.552	37.836
		High	34.603	2.841	29.019	40.187

Source: Field Survey, 2024

Table 14 shows the overall comparison indicates that female participants with high mathematical ability in the timed think-pair-share treatment group had the highest mean score (92.796), followed by female students with high ability (91.990), while male participants with medium ability in the control group had the least mean score (33.810).

VI. DISCUSSION OF THE FINDINGS

The study shows a significant main effect of treatment on students' achievement in Basic Chemistry concepts in secondary schools in the Oyo zone of Oyo State. This implies that the treatment effectively improved students' achievement in Basic Chemistry concepts in secondary schools in the Oyo Zone of Oyo State. The contribution effect of treatment was 88.6 % as indicated by the eta square value of 0.886. This means that participants exposed to TTPS performed better than those exposed to TCC and CLM groups, respectively. The finding is in support with [6] found that Think-Pair-Share learning strategies enhanced students' performance and motivation in chemistry. [2] and [12]'s findings on the effects of Think-Pair-Share showed that senior secondary school students taught using Think-Pair-Share strategy performed significantly better than those taught using convectional method. However, [4] found that Jigsaw instruction than Think-Pair-Share and Cooperative learning strategies.

The study also shows a significant main effect of gender on students' achievement in Basic Chemistry concepts in secondary schools in the Oyo Zone of Oyo State. This implies that gender had a significant effect on students' achievement in Basic Chemistry concepts in secondary schools in Oyo Zone of Oyo State. However, the contributing effect of gender was 1.5 % on students' achievement as shown by the eta square value of 0.015 was very small. This implied that gender had a better effect on students' achievement in Basic Chemistry concepts in secondary schools in Oyo Zone of Oyo State among female participants than their male counterparts. This finding was not supported by [9] and [3] who male chemistry students achieving higher than their female counterparts in chemistry achievement.

There was also a significant main effect of mathematical ability on students' achievement in Basic Chemistry concepts in secondary schools in Oyo Zone of Oyo State This implies that mathematical ability had a significant effect on students' achievement in Basic Chemistry concepts in secondary schools in the Oyo Zone of Oyo State. The contributing effect was 76.9 % with 0.769 eta square value. This implies that mathematical ability had a better effect on students' achievement in Basic Chemistry concepts in secondary schools in the Oyo Zone of Oyo State among participants with high mathematical ability than their counterparts with medium and low mathematical ability, respectively. The finding is in support with [8] that found significant relationship between mathematics knowledge and chemistry achievement in inquiry-based instruction.

There was no significant interaction effect of treatment and gender on students' achievement in Basic Chemistry concepts in secondary schools in the Oyo Zone of Oyo State. This implies that the interaction effect of treatment and gender was not effective on students' achievement in Basic Chemistry concepts in secondary schools in Oyo Zone of Oyo State. This finding is in support with [3] that found no significant interaction effect of teaching and gender of the students on chemistry achievement. However, the contributing effect of treatment and gender was 0.01 % with eta square value of 0.001 from eta square value. This implies that the interaction of treatment and gender had a better effect on students' achievement in Basic Chemistry concepts in secondary schools in Oyo Zone of Oyo State among male participants who were exposed to the TTPS, TCC and CLM learning strategies than their female counterparts.

Furthermore, the study shows no significant interaction effect of treatment and mathematical ability on students' achievement in Basic Chemistry concepts in secondary schools in Oyo Zone of Oyo State. This implies that the interaction effect of treatment and mathematical ability was not effective on students' achievement in Basic Chemistry concepts. The eta square value of 0.002 shows the contributing effect size of 0.2%. This implied that the interaction of treatment and mathematical ability had a better effect on students' achievement in Basic Chemistry concepts. among participants with high mathematical ability who were exposed to TTPS learning strategy than their counterparts with medium and low mathematical ability, respectively.

There was also no significant interaction effect of gender and mathematical ability on students' achievement in Basic Chemistry concepts in secondary schools in the Oyo zone of Oyo State. This implies that the interaction effect of gender and mathematical ability was not effective on students' achievement in Basic Chemistry concepts. The eta square value of 0.006 shows the contributing effect size of 0.6%. It implied that the interaction of gender and mathematical ability had a better effect on students' achievement in Basic Chemistry concepts in secondary schools in Oyo Zone of Oyo State among participants with low mathematical ability, than their female counterparts and other male counterparts respectively. There was no significant interaction effect of treatment, gender and mathematical ability on students' achievement in Basic Chemistry concepts in secondary schools in the Oyo zone of Oyo State. This implies that the interaction effect of treatment, gender and mathematical ability was not effective on students' achievement in Basic Chemistry concepts. Also, the eta square value of 0.007 shows a contributing effect size of 0.7%.

VII. CONCLUSION AND RECOMMENDATION

The following are concluded from the study:

There was significant effect of treatment on chemistry students' achievement in Basic Chemistry concepts.

There was significant effect of gender on chemistry students' achievement in Basic Chemistry concepts.

There was significant effect of mathematical ability on chemistry students' achievement in Basic Chemistry concepts.

There were no 2-way and 3-way interaction effects of treatment, gender and mathematical ability on chemistry students' achievement in Basic Chemistry concepts.

The study establishes the need for active learning strategies to foster meaningful engagement of the students in teaching and learning of chemistry and that students' mathematics knowledge is a prerequisite for chemistry achievement.

The study recommends the use of TTPS and TCC for the teaching and learning of chemistry. Enriching learning environment and teacher training and retraining on modern teaching strategies through workshop are necessary for effective teaching of chemistry.

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