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EFFECTS OF ANALOGY AND TARGET TASK APPROACH (TTA) ON STUDENTS' ACHIEVEMENT IN GAS LAWS IN SENIOR SECONDARY SCHOOLS IN DELTA STATE, NIGERIA

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Abstract:
The study sorts out between the Target Task Approach (TTA), Analogy, and Lecture method that will best increase the achievement and retention of learned concepts. It adopted a quasi-experimental design with a study population of 42,811 and a sample of 294 students drawn from nine government schools in Delta State, Nigeria. The instrument for the study was the Chemistry Achievement Test (CAT) which was found valid in face and content. The reliability was established using the Kuder-Richardson formula 21, and a reliability coefficient of 0.89 was obtained. Chemistry Achievement Test was employed in gathering data, while Analysis of Variance was used to analyse the data after the groups' equivalence was established. The results showed, among others, that all three methods significantly affected achievement; students under Analogy and TTA achieved and retained significantly higher than those in the Lecture method. The study concluded that Analogy and TTA should be employed rather than Lecture method to improve students' achievement and retention. It was recommended that Analogy and Target Task Approach (TTA) should be adopted by Chemistry teachers in teaching Chemistry at the secondary school level, and school administrators should provide and organise in-service training for Chemistry teachers to equip them with the required skills needed to implement Analogy and Target Task Approach (TTA) with no difficulty. This will also ensure in-depth knowledge and mastery of Chemistry concepts.

Keywords: target task approach, analogy method, lecture method, achievement, retention

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1. Introduction

All materials are made up of matter; even human life is a composition of matter, and our national proceeds come from Chemistry related industries. It infers that Chemistry is involved in everything we do, found everywhere we go, and is all around us. As such, understanding Chemistry is vital for almost every profession, especially in science-related courses. This may have necessitated structuring the Chemistry Curriculum at the Senior Secondary School around four themes: Chemistry and life, Chemistry and environment, Chemistry and industry, and Chemistry and the world (Nwanze, 2019). Again, Chemistry plays essential roles in food, Agriculture, clothing, housing, extraction of solid minerals, drilling of petroleum, manufacturing of petrochemical products, production of drugs, etc. Hence various branches such as Medicinal Chemistry, Analytical Chemistry, Biochemistry, Soil Chemistry, Nuclear Chemistry, Environmental Chemistry, and petroleum Chemistry, among others, are found in Chemistry. Consequently, careers are bound to exist from the listed branches; therefore, Chemistry is a relevant science subject that forms a great part of the bedrock for many disciplines. It becomes obvious that teaching Chemistry as a Science subject is inevitable in our schools. An outlook on the role of Chemistry in national development and advancement of education concerning the teaching of Chemistry at Senior Secondary Schools, as stated in the National Policy of Education (Federal Republic of Nigeria, 2013), reveals the following as objectives of teaching Chemistry:

- to provide the students with basic knowledge of Chemistry and principles through an efficient selection of content and sequencing;
- to show Chemistry and its inter-relationship with other subjects;
- to show Chemistry and its link with industry, everyday life, benefits, and hazards; and
- to provide a complete course for the pupils not proceeding to higher education while it is, at the same time, an adequate foundation for a post-secondary Chemistry course.

Given the above objectives, teaching Chemistry becomes compulsory for science students at the Senior Secondary School level. Chemistry helps to define problems as well as observe, analyse, hypothesise, experiment, conclude, generalise and apply the information acquired through the necessary approach (Ministry of National Education, Science, and Technology, 2005).

Despite the importance of Chemistry, it has continued to generate serious attention among parents, teachers, and policymakers because of the poor achievement in external examinations (Gyuse and Ada, 2005 & Ekuri and Asim, 2008). Researches and reports from the West African Examination Council (WAEC) and National Examination Council show that students' performances in Chemistry over the years, as stated earlier, have recorded dwindling successes (WASSCE, 2014 – 2019; Sakiyo & Badau, 2015. Observations from researchers showed that most Nigerian schools still maintain the use of the "talk-chalk" method and persistently apply traditional teaching methods for

teaching rather than interactive and investigative approaches (Abamba, 2012; Inomiesa, 2010; Fatoke, Ogunlade & Ibidiran, 2013). Therefore, the need for better engagement of learners is of necessity to improve achievement and increase retention. Atomatofa (2015) affirmed that the Science Teachers Association of Nigeria (STAN, 2011), in their various workshop, revealed that most researchers emphasised the need for using the student-centred approach in Science teaching to enhance engagement and improve achievement. In affirmation, Atomatofa (2015) stated that the Science Teachers Association of Nigeria (STAN, 2011), in their workshop series, revealed that most researchers emphasised the need for using the student-centred approach in Science teaching to enhance engagement and improve achievement. Models and alternative strategies have been widely advocated (Bybee, 2020; Abamba, 2021).

The Lecture method is an old and widely used teaching method based on the philosophy of idealism (Berrett, 2012; Sharma, 2017). It is a teacher-centred approach used in teaching and learning processes, sometimes referred to as a conventional or traditional teaching method. The teacher dispenses knowledge as authority to students with little or no contribution to the instruction, thereby keeping the students' passive without much engagement with materials. The approach concentrates on talk, regurgitation of scientific facts, and communication of theories, ideas, and facts, with less inquiry-based activities (Ajaja, 2013; Korkor Sam, Owusu & Anthony-Krueger, 2018). The use of the Lecture method is predicated on the fact that it is the simplest method for teachers with less required arrangements; it is economical, saves time, covers the syllabus on time, and can be used among a large number of students (Ajaja, 2009; Sharma 2017; Sam, Owusu & Anthony-Krueger, 2018) but has some strong limitations. Some of these limitations include passiveness with very little scope of students' activity, lack of consideration for individual differences since there is no feedback, inability to rezone and manage students effectively, and retaining monotony of procedures. Thus, the level of students' participation is near zero since they have little or no control over their learning process. Considering these basic weaknesses in the Lecture method, it is necessary for Chemistry teachers to adopt other student-centred approaches to promote the stated earlier instructional objectives and improve students' performances in external examinations.

Analogy, one of the student-centred approaches, compares supposed similar things between two concepts of knowledge that are otherwise unlike (Naseriazar, Ozmen & Badrian, 2011). The two concepts of knowledge involve one familiar, called "analog", and the other less familiar or unfamiliar, called "target". The familiar domain forms the "base", while the less familiar domain (the domain to be learned) forms the "target". Analogy involves observing similarities between familiar and unfamiliar concepts and correlating the knowledge among the concepts so that there is a complete transfer of the target knowledge to the students.

The application of Analogy in Chemistry teaching will help give a clearer understanding of the concepts that appear abstract and complicated since it helps correlate knowledge among familiar and unfamiliar concepts. An analogy is a

fundamental cognitive process with motivational impacts in which the familiar and less familiar concepts of knowledge are linked; it will adequately aid the transfer of the target knowledge to the learners. Also, being a constructivist-based teaching approach, its design will help provide a good means of bringing about conceptual change in students, which will involve using familiar situations to explain a similar unfamiliar concept. For instance, boiling water to produce steam at home (a familiar concept) can be used to explain a change of state from liquid to gas (an unfamiliar concept); the use of a syringe to control the volume of fluid by force explains Boyle's law; explaining atomic structure as an unfamiliar concept with moving wheel of a cycle and so on.

Target Task Approach (TTA) is a task-improved learning approach that requires knowledge transfer from a related task to other targeted tasks. It is a strong student-centred, problem-solving model with an activity-based approach that uses sample tasks to resolve envisaged problems. The model is adopted from the guided discovery method for teaching science; TTA teaches content and languages, and it involves breaking down skills into smaller or more manageable components (Szidon & Franzone, 2009). The approach requires the teacher's presentation of typical solutions similar to the target task and a guide to the students to solve the target task. Also, TTA is contrasted with the traditional method because it is geared towards identifying major problems and solving them through rules and principles problems to improve students' performances. Target Task Approach (TTA) is a problem-solving skill, and its application to Chemistry teaching will help achieve students' effectiveness in learning and studying chemistry. The use of TTA will further commit students to practice and interactions since it is an approach that requires task fulfilment among learners. Students will learn, discover ideas, and understand the target knowledge without guidance in such tasks. The saying "repetition strengthens knowledge" seems applicable in TTA since it involves the practice of a target task. Consequently, it will help further strengthen students' retention of Chemistry concepts and be beneficial in teaching Secondary School Chemistry.

2. Empirical studies on Analogy and TTA on Students' Achievement in Chemistry.

Gongdeni (2016) found that students taught with Analogy performed better than those in the control group in a Chemistry problem-solving test involving electrolysis significantly in their post-test results. Thus, the study recommended using analogies to teach problem-solving tasks in electrolysis and other Chemistry concepts. Naseriazar, Ozmen & Badrian (2011) found no statistical difference between the control and experimental group in terms of achievement with the pretest ($t = 0.093$, $p = 0.654$); however, with post-test scores, there was a statistically significant difference between groups in favour of the experimental group. The study concluded that students in the experimental group showed significantly greater achievement than those in the control group in the post-test. He noted that analogies can help students visualise abstract concepts, organise their thinking about any given concept, and learn meaningfully. Sarantopoulos and Tsaparlis (2004) revealed a statistically significant difference in favour

of the experimental group when Analogy was used to teach 10th and 11th-grade Chemistry. Consequently, Analogy was found to enhance performance in the teaching of Chemistry.

Ugur, Dilber, Senpolat and Duzgun (2012) showed that abstract concepts are easily assimilated with students' prior knowledge, eradicated misconceptions and improved achievement when Analogy was used in teaching Physics. The result obtained revealed that the statistical difference between the experimental and control groups was 31.75% (pretest) to 70.80% (post-test) and 30.10% (pretest) to 51.75% (post-test), respectively. A similar study by Podolefsky (2006) on the concept of electricity (a related concept in electrolysis in Chemistry) was carried out. Results showed that Analogy leads to conceptual change more readily with abstract concepts and can produce a measurable effect in concept learning. Okoronta and Wada (2014) Found a significant difference between those students taught using analogy instructional strategy and those who were taught using the Lecture method ($df = 80$, $t = 0.02$, $P = 0.000 < 0.05$) while significant main effects in students' achievements were also observed ($F = 82.44$, $P = 0.0000 < 0.005$).

Nbina (2011) found a significant difference in achievement between students taught physical Chemistry using the Target Task Approach (TTA) performed and those taught with the expository method in favour of TTA. Therefore, the target task approach was more effective than the expository method in fostering students' achievement in chemistry. Mandina and Eshiwet (2018) showed a significant difference in performance between the experimental and control groups when TTA is employed in Teaching Physical Chemistry. Consequently, it can be concluded that students taught using the Target-Task Model performed better than those taught using the conventional Lecture method. Further studies by Eze (2002), Olaniyan and Omosewo (2015), and Espinosa, Monterola, and Punzalan (2013) all confirmed a significant difference between TTA and Lecture method in favour of TTA.

How much a student retains what is learned is of utmost importance because most external examinations consider the scheme of work of three years and above (Abamba, 2012, Abamba and Chukwuka, 2021). WAEC, NECO, and JAMB consider works from SS1-3 both for the award of certificates and selection into the institutions of higher learning. Therefore, there is a need to employ strategies that will engage learners to enable them to retain concepts longer.

Therefore, the problem that this study seeks to solve is: will the use of Analogy and Target Task Approach (TTA) enhance students' achievements and retention better than the Lecture method in Senior Secondary School Chemistry?

3. Hypotheses

Ho_1: There is no significant effect in the mean achievement scores of students taught Chemistry using Analogy, Target Task Approach and Lecture method.
Ho_2: There is no significant difference in the mean achievement scores of students taught Chemistry using Analogy, Target Task Approach, and Lecture method.

Ho_3: There is no significant effect in the mean retention scores of students taught Chemistry using Analogy, Target Task Approach, and Lecture method.
Ho_4: There is no significant difference in students' means retention scores in Chemistry among groups taught using Analogy, Target Task Approach, and Lecture method.

4. Material and Methods

This study employed a non-randomized pre-test, post-test control group quasi-experimental design. The population of the study consisted twenty-five thousand, eight hundred and eighty-six (25,886) students of Senior Secondary School Two (SS2) across one hundred and forty-nine (149) public schools spread across the eight (8) Local Government Areas of Delta Central Senatorial District. Six (6) Chemistry teachers and one hundred and ninety-eight (198) senior secondary school (SS2) Chemistry students of the 2012/2013 academic session from six (6) selected secondary schools having Chemistry laboratories in Delta Central Senatorial District were sampled using stratified random sampling to avoid the problem of inadequate Chemistry laboratory facilities. The one hundred and ninety-eight (198) Senior Secondary School Two (SS2) Chemistry students were from intact classes of the sampled schools comprising both males and females.

Three instruments will be used in the study:

1) Chemistry Practical Ability Test (CPAT);
2) Chemistry Process Skills Rating Scale (CPSRS);
3) Instruction Manual for Quantitative and Qualitative Analyses (IMQQA).

The Practical Ability Test items were drawn from West African Senior School Certificate Examination (WASSCE) Chemistry question Paper 3. It is an alternative to practical paper which is capable of helping to ascertain the level of understanding and acquisition of Chemistry Process Skills in Quantitative and Qualitative Analyses.

Chemistry Process Skills Rating Scale (CPSRS) is a rating scale designed to assess the level of acquisition of Chemistry Process Skills in CPAT. It is made up of grading points to rate each of the Chemistry Process Skills in Quantitative and Qualitative Analyses.

The instructional manual for Quantitative and Qualitative Analyses (IMQQA) is the teachers' instructional manual to teach using the laboratory method after administering the pre-test instrument.

The CPAT was adopted from 2003-2012 November WASSCE Chemistry paper 3. The instrument was not validated since it was already standardized. The CPSRS was constructed and developed with respect to the specified curriculum contents on volumetric analysis and was validated by two science education lecturers and a lecturer in measurement and evaluation to ensure its face and content validity. After necessary corrections and modifications, the instruments were administered accordingly.

The CPAT was administered to the sampled students in SS2. Responses to the designed questions in the CPAT were collected and rated using CPSRS. Each process skill was rated using two (2) for those who answered the question correctly, one (1) for those

who got half of the answer and zero (0) for those who failed to answer the question correctly. CPAT and CPSRS were trial tested in a school that is not part of the study. The reliability was carried out using the Pearson Product Moment Correlation Coefficient. The reliability coefficient was r = 0.707.

4.1 Treatment Procedure

The Chemistry Practical Ability Test (CPAT) was administered to the SS2 Chemistry students from the sampled schools. Three schools were used as the experimental group while the other three schools as the control group. The trained Chemistry teachers were used to both teach using the laboratory method and administer the CPAT, and the responses were retrieved the same day for marking and rating using CPSRS by the researcher. Members of the experimental group of the study were treated at another time using the laboratory method of instruction (Instructional Manual for Quantitative and Qualitative Analyses (IMQQA)) while the conventional method remained unchanged for the control group. Thereafter, the CPAT was administered to the students in both groups accordingly by the same trained teachers. Responses from each student were collected that same day for scoring and rating by the researcher using the CPSRS. Mean and standard deviation, t-test analysis, and ANCOVA were used to analyze the data collected.

5. Results and Discussion

The result of the analysed data began with establishing the equivalence of the Analogy groups, Target Task Approach (TTA) groups, and Lecture method groups; this was computed and presented in Table 1, as shown below.

Analysis of Variance was used to establish equivalence on pretest mean scores for the three groups. The result obtained is represented in Table 1, as shown below.

Table 1: Summary of ANOVA comparison of pretest mean achievement scores of students taught Chemistry using Analogy, Target Task Approach (TTA), and Lecture methods

Source of Variation	Sum of Squares	Df	Mean Square	F	P-value
Between Groups	18.388	2	9.194	.299	.742
Within Groups	7706.970	251	30.705		
Total	7725.358	253	253		

Table 1 revealed no significant difference between the pretest mean scores of students taught Chemistry using analogy, TTA, and Lecture methods since F(2, 251) = 0.299; P = (0.742). Therefore, the result showed that the students in the three groups were equivalent in the knowledge of Chemistry concepts taught before treatment.

Ho_1: There is no significant effect on the mean achievement scores of students taught Chemistry using Analogy, Target Task Approach, and Lecture method.

Table 2: Paired sample test for post-test and pretest mean achievement scores of students taught using Analogy, TTA and Lecture methods in Chemistry

Groups		א	SD	T	Df	Sig. (2- tailed)
Pair 1: Lecture	post-test – pre-test	3.91209	3.19252	11.689	90	.000
Pair 2: TTA	post-test – pre-test	13.44595	5.79594	19.956	73	.000
Pair 3: Analogy	post-test – pre-test	10.83146	5.62914	18.153	88	.000

Table 2 shows that there is a difference between the post-test and pretest mean achievement scores of students taught Chemistry using Analogy, t(18.153)>p(0.000). Also, there is a significant difference between the post-test and pretest mean achievement scores of students taught Chemistry using TTA, t(19.956)>p(0.000). Similarly, for those taught with the Lecture method, there is a significant difference, P (11.689)>p (0.000). This showed that all three methods significantly affected the students' achievement. The result showed that TTA had the highest effect, followed by analogy and Lecture method.

H_{O2}: There is no significant difference in the mean achievement scores among students taught Chemistry using Analogy, Target Task Approach, and Lecture method.

To determine the difference between the three methods of achievement, Table 3 presents the descriptive statistics.

Table 3: Mean and Standard Deviation of post-test achievement scores of students taught Chemistry using Analogy, Target Task Approach (TTA), and Lecture methods

Source of Variation	N	Mean	SD
Lecture	91	21.6374	6.55492
TTA	74	31.1632	6.45963
Analogy	89	27.9888	6.35770
Total	254	26.6378	7.55027

The result showed that the post-test achievement scores of students taught using the Lecture method had a mean score of 21.6374 with a standard deviation of 6.55492. In contrast, their counterparts in the experimental group (TTA and Analogy) had mean scores of 31.1622 and 27.9888, with standard deviations of 6.45963 and 6.35770, respectively. Comparing the difference in mean scores between the pretest scores, as shown in Table 8, and the post-test scores, as shown in Table 10, the mean gain of 3.9121, 13.446, and 10.8313 for the Lecture method, TTA and Analogy was observed, respectively. This shows a difference in the mean achievement scores among students taught Chemistry using the three groups. To establish whether the difference was significant, ANOVA was employed, as shown in Table 4.

Table 4: Summary of ANOVA comparison of post-test mean achievement scores of students taught Chemistry using Analogy, Target Task Approach posttest (TTA) and Lecture methods

Source of Variation	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	3952.601	2	1976.301	47.378	.000
Within Groups	10470.076	251	41.713		
Total	14422.677	253			

The table revealed a significant difference between the post-test mean scores of students taught Chemistry using analogy, TTA, and lecture methods since F(2, 251) = 47.378, P=0.000. Thus, HO_1 is therefore rejected. A post-hoc analysis using a Scheffe test was employed to determine the direction. The result obtained is represented in Table 5, as shown below.

Table 5: Summary of Scheffe post-hoc test comparison of post-test mean achievement scores of students taught Chemistry using Analogy, Target Task Approach post-test (TTA), and Lecture methods

Groups		Mean Diff (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Lecture	TTA	-9.52480*	1.01098	.000	-12.0143	-7.0353
	Analogy	-6.35140*	.96285	.000	-8.7223	-3.9805
TTA	Lecture	9.52480*	1.01098	.000	7.0353	12.0143
	Analogy	3.17340*	1.01606	.008	.6714	5.6754
Analogy	Lecture	6.35140*	.96285	.000	3.9805	8.7223
	TTA	-3.17340*	1.01606	.008	-5.6754	-.6714

*. The mean difference is significant at the 0.05 level.

The result showed a significant difference between the post-test means achievement scores of students taught Chemistry using the three methods. However, I-J values indicated that TTA performed better than the other groups with an I-J value of 9.52480, followed by Analogy with an I-J value of 6.35140. Then the Lecture method was the least, with an I-J value of 3.17340. Therefore, TTA and Analogy showed better performance than the Lecture method.

Ho_3: There is no significant effect on students' means retention scores in Chemistry groups taught using Analogy, Target Task Approach, and Lecture method.

The post-test and test of retention scores of the students in Chemistry between groups using Analogy, Target Task Approach, and Lecture method were computed and compared using a t-test, as shown in Table 6.

Table 6: Mean and Standard Deviation of post-test and retention achievement scores of students taught Chemistry using Analogy, Target Task Approach (TTA) and Lecture methods

Groups		**N**	**א**	**SD**
Pair 1: Lecture	Post-test	91	21.6374	6.55492
	Retention	91	19.4835	6.17947
Pair 2: TTA	Post-test	74	31.1622	6.45963
	Retention	74	28.8514	6.62226
Pair 3: Analogy	Post-test	89	27.9888	6.35770
	Retention	89	25.9438	6.98596

Table 6 showed retention mean scores of 19.4835, 28.8514, and 27.9888 with standard deviations of 6.17947, 6.62226, and 6.98596 for students taught Chemistry using lecture, TTA, and Analogy methods, respectively. For the post-test, a mean achievement score of 21.6374, 31.1622, and 27.9888 with standard deviations of 6.55492, 6.45963, and 6.35770 were obtained for students taught Chemistry using lecture, TTA, and Analogy methods, respectively. The result showed a mean difference in all the groups, indicating a loss in retention.

This hypothesis was tested using a paired sample t-test to compare the test of retention scores and post-test mean achievement scores, as indicated in Table 7.

Table 7: Paired sample test for posttest and test of retention mean achievement scores of students taught using Analogy, TTA, and Lecture methods in Chemistry

Groups		**א**	**SD**	**% loss**	**t**	**Df**	**Sig.(2-tailed)**
Pair 1: Lecture	Post-test – retention	2.15385	1.35747	9.95	15.136	90	.000
Pair 2: TTA	Post-test – retention	2.31081	2.74947	7.42	7.230	73	.000
Pair 3: Analogy	Post-test – retention	2.04494	2.34961	7.31	8.211	88	.000

Table 7 showed a significant difference between the post-test and retention mean achievement scores of students taught Chemistry using Analogy, P(0.000) < 0.05. Also, there is a significant difference between the post-test and retention mean achievement scores of students taught Chemistry using TTA, P(0.000) < 0.05. Similarly, there is a significant difference for those taught with the Lecture method, P (0.000) < 0.05. However, the groups' post-test and retention mean achievement scores showed 2.15385, 2.31081, and 2.04494 for students taught with lecture, TTA, and Analogy, respectively. From the result obtained in Table 7 above, there is a significant effect, which indicated that Analogy had the least mean percentage loss in retention at 7.31%, followed by TTA with 7.42% and the highest mean loss in retention being the Lecture method, with 9.95%.

H_{O4}: There is no significant difference in the mean retention scores in Chemistry among groups taught Chemistry using Analogy, Target Task Approach, and Lecture method.

The descriptive statistics are presented in Table 8 below.

Table 8: Mean and Standard Deviation of post-test achievement scores and test of retention scores of students taught Chemistry using Analogy, Target Task Approach (TTA) and Lecture methods

Groups	N	x̄ (posttest)	SD (posttest)	x̄ (retention)	SD (retention)	x̄ loss	% loss
Lecture	91	21.6374	6.55492	19.4835	6.17947	2.1539	9.96
TTA	74	31.1632	6.45963	28.8514	6.62226	2.3118	7.42
Analogy	89	27.9888	6.35770	25.9438	6.98596	2.0450	7.31
Total	254	26.6378	7.55027	24.4764	7.65082	2.1614	8.11

Table 8 showed that students taught Chemistry using the Lecture method had 21.6374 as post-test mean achievement scores with a standard deviation of 6.55492. For those taught using TTA, the post-test mean achievement score was 31.1632 with a standard deviation of 6.45963, while students taught using Analogy had a mean achievement score of 27.9888 with a standard deviation of 6.35770. However, the mean score obtained from the test of retention indicated 19.4835with standard deviation of 6.17947 for students taught using the Lecture method (control group), while their counterparts in the experimental group (TTA and Analogy) had mean scores of 28.8514and 25.9438, with a standard deviation of 6.62226 and 6.98596 respectively. The mean loss showed a drop in the mean post-test achievement score among students taught Chemistry using the three groups. The drop is indicated in percentage for the three groups as 9.96 (lecture), 7.42 (TTA), and 7.31 (analogy).

This is to determine if there is a significant difference in the test of retention means scores of the students taught Chemistry using the three groups. ANCOVA was employed, and the result is presented in Table 9.

Table 9: Summary of ANOVA comparison of mean scores on students' retention in Chemistry using analogy, Target Task Approach post-test (TTA) and Lecture methods

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	3876.549	2	1938.275	44.500	.000
Within Groups	10932.809	251	43.557		
Total	14809.358	253			

Table 9 showed that there is a significant difference between the mean scores on students' retention in Chemistry using lecture, TTA, and Analogy methods, $F(2, 251) = 44.500$; $P=0.000$ Thus, HO_4 is therefore rejected since there is a significant difference in the retention means scores of students taught Chemistry using analogy, TTA and Lecture methods. A post-hoc analysis using Scheffe's test was employed to determine the direction of the work.

The result obtained is represented in Table 10, as shown below.

Table 10: Summary of Scheffe's post-hoc test comparison of mean retention scores of students taught Chemistry using Analogy, Target Task Approach post-test (TTA) and Lecture methods

Groups (I)	(J)	Mean diff (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Lecture	TTA	-9.36783*	1.03308	.000	-11.9117	-6.8239
	Analogy	-6.46030*	.98390	.000	-8.8831	-4.0375
TTA	Lecture	9.36783*	1.03308	.000	6.8239	11.9117
	Analogy	2.90753*	1.03827	.021	.3509	5.4642
Analogy	Lecture	6.46030*	.98390	.000	4.0375	8.8831
	TTA	-2.90753*	1.03827	.021	-5.4642	-.3509

*. The mean difference is significant at the 0.05 level.

Table 10 showed a significant difference between the mean scores on students' retention in Chemistry using Analogy, TTA, and Lecture methods. However, I-J values indicated that TTA performed better than the other groups with an I-J value of 9.36783, Analogy with an I-J value of 6.46030, and the Lecture method the least with an I-J value of 2.90753. Therefore, TTA and Analogy showed better retention of knowledge than the Lecture method.

6. Discussion of Results

The first result revealed a significant difference in the mean achievement scores among students taught Chemistry using the three teaching methods. This increase in the achievement scores is a result of the treatment introduced, the use of analogy, TTA, and Lecture methods. The treatment outcome yielded a mean gain (mean differences between post-test and pretest scores) of 13.446, 10.8315, and 3.9131 for students taught using TTA, Analogy, and Lecture methods, respectively. Also, the second result revealed a significant effect of the teaching methods (Analogy, TTA, and lecture) on students' achievement in chemistry. This is predicated on the fact that the post-test achievement scores of all the students taught using Analogy, TTA, and Lecture methods were significantly higher than the pretest scores. For the pretest scores, $F(2, 251) = 0.299$; $P(0.742) > 0.05$, while post-test scores indicate $F(2, 251) = 47.378$; $P(0.000) < 0.05$. This is further observed in the mean difference, which showed that TTA is higher than the Lecture method by a mean difference of 9.52480, while Analogy is higher than the Lecture method by a mean difference of 6.35140. Consequently, the exposure of students in various instructional groups to three instructional methods has varying effects on students' achievement in chemistry. This implies that the three teaching methods can potentially enhance students' achievement but at different measures or levels. This finding agrees with research work stating that the difference observed in experimental research is a function of the treatment provided and not by chance (Borich, 2004; Nbina, 2011; Ajaja, 2013).

The third result revealed a significant difference in the mean retention scores among students taught Chemistry using the three teaching methods. Again, this

difference in the test of retention scores is due to the treatment provided using analogy, TTA, and Lecture methods. Although the difference in the mean retention scores was higher in the experimental group (Analogy and TTA) when compared with their counterparts in the control group (Lecture method).

The fourth result revealed a significant effect of the teaching methods (Analogy, TTA, and lecture) on the students' retention in chemistry. This is also predicated on the fact that the test retention scores of all the students taught using Analogy, TTA, and Lecture methods were significantly higher than the pretest scores. For the pretest scores, $F(2, 251) = 0.299$; $P(0.742) > 0.05$, while the test of retention scores indicated $F(2, 251) = 44.500$; $P(0.000) < 0.05$. The result further observed a mean difference which showed that TTA is higher than the Lecture method by a mean difference of 9.36783, while Analogy is higher than the Lecture method by a mean difference of 6.46030. Nevertheless, the differences observed among the groups were relatively a loss in retention when post-test mean scores were compared with the retention mean scores. The mean retention scores loss in percentage revealed that the Lecture method had the highest (9, 95%), followed by TTA (7.42%) and Analogy (7.31%) the least. Consequently, the exposure of students in various instructional groups to the three instructional methods has varying effects on students' retention in chemistry. These differences implied that Analogy and TTA enhanced students' retention levels better than the Lecture method.

The observed dominance of Analogy and TTA over the Lecture method may be attributed to the level of students' participation and interaction, practice on the target task, and comparison and correlation of familiar concepts of knowledge with the target task. However, the three teaching methods showed the potential to enhance students' achievement at different measures. This finding agrees with the research work of Arokoyu and Aderonmu (2018), which stated that using real-life phenomena and classroom interactions helps students perform better and improves retention ability. Again, this finding agrees with Nbina's (2011) and Mandina and Eshiwet (2018) work, which says the target task problem-solving approach performs significantly better than conventional and expository methods. On the side of Analogy, the findings in the study agree with the work of Yilmazoglu (2004), Christidou, Theodosiou, and Hatzinikita (2018) and Rahayu and Sutrisno (2019), which states that multiple analogies significantly improve the acquisition of scientific concepts in Chemistry and help students recall abstract concepts easier because students were found to exhibit a better understanding of the variety of characteristic properties of matter.

6.1 Recommendations

The following recommendations were made based on the findings:

1) In teaching Chemistry at the secondary school level, Chemistry teachers should adopt the Analogy and Target Task Approach (TTA), particularly concepts where students express difficulty due to the problem of abstraction. These methods will promote active participation, self-reliance, and confidence during teaching and learning.

2) School administrators should provide in-service training for Chemistry teachers to equip them with the required skills to implement the Analogy and Target Task Approach (TTA) with no difficulty. This will also ensure in-depth knowledge and mastery of Chemistry concepts.

7. Conclusion

Given the above findings, the study concludes that Analogy, Target Task Approach, and Lecture methods positively affect students' achievement and retention in Chemistry. Analogy and Target Task Approach enhanced students' achievement and retention in Chemistry more than the Lecture method. However, the Target Task Approach improves students' achievement most while Analogy enhances students' retention in Chemistry.

7.1. Contribution to knowledge

1) The study has established that Analogy and Target Task Approach (TTA) significantly affect students' achievement and retention in Chemistry compared to the Lecture method.
2) The study has affirmed that the Analogy and Target Task Approach (TTA) are more effective teaching method for enhancing students' achievement and retention in Chemistry than the Lecture method.

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The authors declare no conflict of interest.

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