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Effects of Differentiated Instruction on Chemistry Students' Achievement and Retention in Secondary Schools, Abuja, Nigeria

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Abstract: This study investigated the effects of differentiated instruction on academic achievement and retention of secondary school students in chemistry in FCT Nigeria. Four research questions were raised and answered and four null hypotheses were formulated and tested at 0.05 level of significance. The research design adopted for this study was the quasi experimental, experimental design. The population of the study was 6,309 SS II Chemistry students in senior secondary school two (SS II) in Kuje Area council of the FCT. The study sample consist of 75 SSII chemistry students drawn from two public schools using simple random sampling technique by balloting. The study used Chemistry Achievement Test (CAT) and Chemistry Retention Test (CRT) as instruments for data collection. The reliability of the instrument was determined using Kuder Richardson formula 20 (KR-20) and the reliability coefficient of 0.85 was obtained. Data were analyzed using mean and standard deviation to answer the research questions and the null hypotheses were tested using Analysis of Covariance (ANCOVA). Results showed among others that there was difference in the academic achievement scores of students taught chemistry using differentiated instruction compared to their counterparts in the control group and gender friendly. Based on the findings, it was concluded that differentiated instruction strategy significantly improves students' achievement in chemistry compared to traditional teaching methods. By catering to individual learning styles and it is gender friendly. The study recommends that teachers should incorporate differentiated instruction techniques into their teaching practices to accommodate diverse learning needs and enhance students' engagement and understanding of chemistry.

Background

Science plays a crucial role in advancing humankind's understanding of the world around us, providing explanations for natural phenomena and technological innovations that improve our quality of life. It serves as the foundation for progress in various fields, including medicine, agriculture, engineering, and environmental conservation. Through scientific research and discoveries, society gains valuable insights into complex issues such as climate change, disease

prevention, and sustainable energy sources. Science enables us to make informed decisions based on evidence and data, leading to more effective policies and solutions to global challenges. It fosters critical thinking, problem-solving skills, and innovation, driving economic growth and technological advancements. By promoting curiosity and exploration, science inspires future generations to pursue careers in STEM fields, contributing to societal development and prosperity. Chemistry is one of the cornerstone of science and it requires both theoretical understanding and practical application. Many students struggle to grasp the subject's abstract concepts, particularly in large, heterogeneous classrooms. The traditional "one-size-fits-all" approach has become increasingly inadequate for meeting the diverse needs of modern learners in Chemistry classroom. It has created a serious task for teachers to make learning environment interesting, collaborating, and incorporating for science students. Moreover, until meaningful teaching is achieve, meaningful learning might be difficult for the students. This task places a demand on teachers to embrace change in their teaching instructions Aregbesola, (2023). Such shift has given rise to differentiated instruction (DI), an innovative, student-centered teaching strategy.

Differentiated instruction aims to address students' varied abilities, learning preferences, and levels of readiness by modifying content, instructional methods, and learning activities. This approach is particularly vital in Chemistry within secondary schools students, where challenges in achievement and retention persist. Ojelade, et al., (2023) asserted that abstract nature of Chemistry is exacerbated by traditional teaching methods, which do not cater for the unique learning needs of each student. In chemistry, achievement can be evaluated through a student's ability to understand concepts, solve chemical equations, and apply these concepts to problem solving. Moreover, retention refers to a student's ability to retain and recall the knowledge gained over time (Ugur, et al., 2020). Traditional, teacher-centered instructional methods often result in marginal achievement and retention rates, as they fail to engage students in meaningful ways. In contrast, differentiated instruction enhances achievement and retention by allowing students to engage deeply with the material, through varied instructional methods that match their learning preferences. Differentiated instruction enables teachers to cater to a wide range of learners by offering multiple pathways to learning. Whether through visual aids, interactive simulations, or hands-on experiments, this approach ensures that all students, regardless of their starting point, can engage with and master the content. In chemistry, the use of varied instructional strategies has been shown to improve both engagement and comprehension, as students are given opportunities to explore the material in ways that align with their individual learning styles (Santangelo, et al., 2021).

Chemistry is a crucial subject for students aiming to pursue science-related courses in Nigerian tertiary institutions. However, the prevalent lecture-based teaching style, where teachers primarily deliver information without practical, hands-on activities, fails to address students' diverse learning needs. Students learn in various ways, such as visually, auditory, and through hands-on experiences, but the lack of differentiation in teaching methods contributes to poor academic achievement in chemistry. The suboptimal results in internal and external exams like WAEC reflect this issue. Effective learning occurs when students actively engage and take control of the learning process, enhancing their understanding and retention of concepts. However, current teaching strategies in chemistry have not effectively closed the gap in student achievement. Factors such as inadequate instructional methods, lack of engagement, and insufficient real-world applications hinder students' comprehension and retention. Differentiated instruction, which adapts teaching methods to meet diverse student needs, has been proposed as a solution to these challenges. This study aims to evaluate the impact of differentiated instruction on improving academic achievement and retention in chemistry among secondary school students in FCT, Abuja, Nigeria.

Purpose of the Study

The aim of this study is to investigate the effect of differentiated instruction on secondary school students' academic achievement and retention in chemistry in FCT, Nigeria. Specifically, the study seeks to address the following objectives;

i. Determine the difference between the academic achievements of students taught chemistry with differentiated instruction and those taught using conventional method.

ii. Ascertain the difference in the academic achievement of male and female students taught chemistry using differentiated instruction.

iii. Find out the difference in retention ability of students taught chemistry with differentiated instruction and those taught using conventional method

iv. Find out if any difference exists in the retention ability of male and female students taught chemistry using differentiated instruction.

1.4 Research Questions

The study is guided by the following research questions:.

i. What difference exist between the mean achievement scores of students taught chemistry with differentiated instruction and those taught using conventional method?

ii. What difference exist between the mean achievement scores of male and female students taught chemistry using differentiated instruction?

iii. What difference exist between retention mean scores of students taught chemistry with differentiated instruction and those taught using conventional method?

iv. What is the possible gender difference in the retention mean scores of male and female students taught chemistry using differentiated instruction?

1.5 Hypotheses

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

$H0_1$: There is no significant difference between the academic achievement of Senior Secondary Students taught Chemistry with Differentiated Instruction and their counterparts taught using Conventional method.

$H0_2$: There is no significant difference between the academic achievement of male and female students taught chemistry using Differentiated Instruction.

$H0_3$: There is no significant difference between the retention of Senior Secondary School Students taught chemistry with Differentiated instruction and those exposed to Conventional method.

$H0_4$: There is no significant difference in the retentive ability of male and female students taught chemistry using Differentiated instruction.

Literature review

Howard Gardner's Multiple Intelligence Theory challenges the traditional view of intelligence as a single, measurable entity, proposing instead a diverse set of intelligences that individuals possess in varying degrees. Initially, Gardner identified seven types of intelligence, later expanding the model to include more. The main eight intelligences are linguistic, logical-mathematical, musical, spatial, bodily kinesthetic, interpersonal, intrapersonal, and naturalistic. Each intelligence highlights distinct abilities, such as language use, mathematical reasoning, musical skills, spatial awareness, physical coordination, social interaction, self-awareness, and understanding the natural environment. This theory's educational impact lies in its acknowledgment of varied student strengths, guiding differentiated instruction. For instance, chemistry lessons can be tailored to

leverage students' dominant intelligences, improving engagement and achievement through varied assessments and collaborative learning. By recognizing diverse learning preferences, educators can foster holistic student development and deeper understanding of chemistry concepts.

Differentiated Instruction in chemistry is a pedagogical approach that aims to cater to the diverse learning needs of students by providing varied teaching methods, content, and assessment strategies (Ojonugwa et al., 2020). This method allows students to engage with the material based on their individual abilities and preferences, thus preventing frustration and enhancing their learning experience (Rahayu, 2023). Research has shown that implementing differentiated instruction can have a positive impact on students' problem-solving skills and interest in learning, especially among low achievers (Ojonugwa et al., 2020). In the context of chemistry education, differentiated instruction can be applied through various methods such as context-based learning, interactive digital teaching modules, and virtual laboratory experiments (Güth, 2023 & Wu et al., 2019). These approaches provide students with diverse learning experiences and challenges, which can lead to improved achievement in chemistry (Wu et al., 2019). Additionally, incorporating brain-based learning strategies has been found to significantly enhance students' chemistry achievement, showing a clear differentiation between the impacts of brain-based learning and traditional teaching methods (Alanazi, 2020). Danjuma (2017) who analyzed the impact of a grade 2 social sciences class taught with differentiated instruction on students' academic achievement and retention of knowledge in Gombe State, Nigeria. He found out that both the experimental and control groups showed greater academic achievement from pre-test to post-test, but students in experimental group demonstrated higher retention ability.

However, research has shown that differentiated instruction can significantly affect students' academic achievement. Ahamad, et al., (2021) investigated the effect of online multiple intelligence-based learning on achievement in motion concept among 10th-grade students. The online multiple intelligence-based learning had a positive effect on achievement in motion concepts, with the mathematical logic and Intrapersonal intelligence group performing significantly better than others do. Cakiroglu, et al., (2020) highlights that differentiated teaching approaches, which incorporate flexible grouping, formative assessment, and scaffolded tasks, lead to improve achievement in science subjects. This is particularly important in chemistry, a subject that often poses challenges due to its abstract and theoretical nature. By providing multiple pathways for students to engage with content, differentiation helps bridge the gap between students with varying abilities, ensuring that all students have access to meaningful learning experiences (Tomlinson, et al., 2020). Njagi (2015) also investigated the effectiveness of differentiated instruction on students' achievement in mathematics by gender. He found that when students were taught using differentiated instruction, gender did not affect their achievement in mathematics.

Retention of knowledge is also positively influenced by differentiated instruction. According to research by Subban and Round (2020), differentiated teaching strategies help students retain more information because the content is present in ways that align with their preferred learning modalities, whether visual, auditory, or kinesthetic. Additionally, differentiated instruction supports deeper understanding by encouraging students to engage with material at their own pace, thus fostering long-term retention (Morgan, 2020). This is crucial in subjects like chemistry, where cumulative knowledge is necessary for mastering progressively complex topics. Brown (2014) that established that students' retention in science seems to improve through the use of some instructional procedure aided models. Ogunkunle, et al., (2014) who investigated the effect of differentiated instructional strategies on students' retention in geometry in senior secondary schools and found that students taught geometry using differentiated instruction had higher retention ability than the conventional method. Further analysis of results from the table revealed that there was no significant difference in the retention mean scores of male and female students taught chemistry using differentiated instructional strategy.

The gender dimension in academic achievement and retention under differentiated instruction is another area of interest. Studies such as that by Kamaruddin, et al., (2020) suggest that differentiated instruction can equally benefit both male and female students in Chemistry, though there may be subtle differences in how each gender responds to specific instructional strategies. Differentiated instruction is a valuable tool in promoting gender equity in students' achievement in chemistry. Differentiated instruction is a valuable method in promoting gender equity in students' achievement in chemistry. While some studies suggest that male students excel in their achievement in chemistry compared to their female counterparts (Odewumi et al., 2019). Additionally, findings have shown that female students in homogeneous ability groupings outperformed their counterparts in heterogeneous groupings, emphasizing the importance of considering the impact of instructional environments on gender related achievement gaps (Gambari et al., 2018). It is essential to ensure that both male and female students are given equal opportunities in the classroom to enable them to achieve equally (Aregbesola, et al 2023 Bizimana et al (2022) that there was statistically significant gender difference between male and female mean retention scores with females retained significantly higher than males. This implies that the utilization of gender neutral instructional strategies such as differentiated instructional strategy is an effective strategy in enhancing the retention ability of both male and female students in chemistry.

Studies have shown that guided discovery methods of instruction can improve students' understanding and achievement in chemistry (Tella, et al., 2022). Furthermore, the use of problem-solving instructional strategies has been found to enhance student achievement in chemistry compared to conventional methods (Shadreck, et al., 2018). It is crucial to consider the effectiveness of various teaching strategies, such as computer-assisted concept mapping and blended instructional strategies, in promoting students' achievement and retention in chemistry (Shamsuddin, 2017, Edem, et al., 2021). The concept of student retention abilities in chemistry in Nigerian secondary schools is influenced by various factors. Gender, teaching resources, and academic achievement have been studied in the context of thermochemistry in Cross River State, Nigeria (Ofre, et al., 2019). The use of online platform has been proposed as a solution to the challenges faced in conducting practical chemistry sessions in Nigerian secondary schools (Aregbesola, et al., 2022). Additionally, the effectiveness of learning cycle models on reducing anxiety towards chemistry among Nigerian senior secondary students has been explored (Alebiosu et al., 2017). Kenni (2020) examined the effects of Advance Organizer teaching strategy on students' gender in secondary school Chemistry in Ekiti State, Nigeria. The study discovered that students achievement in Chemistry was at marginal level before their exposure to expository advance organizer. However, the use of expository advance organizer improves the achievement of students in Chemistry more than conventional method of instruction. Also, it was found that score level and gender classification of students has no influence on their academic achievement when exposed to expository advance organizer

Liou, Cheng, et al., (2023) carried out a study on differentiated instruction to design the undergraduate evidence-based nursing course and evaluate the effects of Differentiated Instruction on students' learning outcomes and learning satisfaction. One-group pretest–post-test pre-experimental design was applied. Ninety-eight undergraduate nursing students enrolled in the evidence-based nursing course 2020 participated in this study. Students' learning outcomes including preferred learning styles, classroom engagement, collaborative learning, attitudes towards evidence-based nursing, learning satisfaction and evidence-based nursing knowledge were measured using validated questionnaires. The Differentiated Instruction increased students' learning interests, promoted focused and independent thinking, and enhanced academic achievement. Students' classroom engagement, attitudes towards evidence-based nursing, evidence-based nursing knowledge and learning satisfaction were improved after the course. The course designed with Differentiated Instruction provided a supportive learning environment and

furnished a vivid pedagogical way for the unique nursing profession. The reviewed study shares similarity with the present study in the sense that both studies investigated the effect of Differentiated Instruction on students learning outcomes. However, they differ in terms of category of students involved in the study. While the reviewed study focused nursing students, the present study focused on chemistry students in secondary schools. In addition, the reviewed study differs from the present study in terms of dependent variables investigated. While the reviewed study looked at variables such as preferred learning style, classroom engagement and attitude towards evidence-based nursing, the present study concern itself with achievement and retention of students in chemistry.

Methodology

This study adopted quasi-experimental research design. The experimental group underwent the prescribed treatment, while the conventional method was used for the control group that served as the benchmark point of comparison. The target population consists of a total of 11public senior secondary schools in Kuje Area Council of FCT, Abuja with a total number of 6,309 SS II Chemistry students. The sample size comprised 75 SSII students offering chemistry in Kuje Area Council. From the two selected schools, intact senior secondary school (SSS) classes were selected for the study. There was, therefore 45 students in the experimental group and 30 students in the control group, giving the total of 75 students involved in the study. Pilot test of the instruments was carried out with a view to ascertaining the general suitability of the Chemistry Achievement Test (CAT). Thirty (30) senior secondary school two (SSSII) students were used for the pilot test. The Kuder-Richardson formula 20 was used to determine the reliability of the CAT. The index obtained was 0.85 which was considered reliable for this study.

Table 1: Sample Distribution of Students into Experimental and Control Group

S/n	Group	No of student
1.	Experimental	45
2.	Control	30
	Total	**75**

The instruments for data collection in the study was a 40-item Chemistry Achievement Test (CAT). The Chemistry Achievement Test (CAT) contained 40 items, which were multiple choices; each having four options lettered A-D. The items of the test were drawn from past WAEC objective questions on topics treated. A pre-test was administered to the sample schools and used to establish the homogeneity of the groups. The experimental group was taught Chemistry with Differentiated Instruction, while the control group was taught with the conventional teaching method for a period of eight weeks. A post-test was administered at the end of the eight weeks and after two weeks, the Chemistry Retention Test (CRT) was administered on the students for post-post-test. The analysis of the data collected with the CAT and CRT were analyzed using the mean and standard deviation to answer the research questions and the two-way ANCOVA was used to test the hypotheses. The hypotheses were tested at a 0.05 level of significance.

Presentation of Data

Table 2: Demographic data showing distributions of respondents in groups and gender.

S/N	Group	Male	Female	Total
1.	Experimental	18 (40%)	27 (60%)	45
2.	Control	16(53.3%)	14 (46.7%)	30
	Total	34 (45.3%)	41 (54.7%)	75 (100%)

Table 2 presented the data on the number of male and female students that were in the sampled schools. For the experimental group the male represents 40% while the female students represent 60%. While for the control group, 53% represent the males and 46% for the female students.

Answers to Research Questions

Research Question one: What difference exist between mean achievements scores of students taught chemistry with Differentiated Instruction and those taught using conventional method in FCT Abuja. To answer this research question, mean and standard deviation were used.

Table 3: **Descriptive statistics showing the difference in the mean achievement scores and standard deviation of experimental and control group.**

Group	No of Students	Pre-Test Mean	SD	Post-test Mean	SD	Mean Gain
Experimental	45	37.51	4.2	55.3	2.8	18.0
Control	30	31.64	4.37	42.2	7.88	10.56
Mean diff.		5.87		13.1		
Total	75					

Table 3 presented data on the mean and standard deviation of academic achievement of students in experimental and control groups. From the result obtained in the table, it showed that the students in the experimental group obtained a pre-test mean score of 37.51 and post-test mean score of 55.3 while the control group had a pre-test mean score of 31.64 and posttest mean score 42.2. The result showed that the students in the experimental group taught with differentiated instruction had a higher mean gain (18.0) compared to their counterpart in the control group with a mean gain of 10.56. The difference in the mean gains of the experimental and control group is in favour of the experimental group. The difference in the mean gain in favour of the experimental group shows that differentiated instruction enhanced students' achievement in chemistry better than conventional method.

Research Question Two: What difference exist between academic achievement mean scores of male and female students taught chemistry using differentiated instruction in FCT Abuja. To answer this research question, the mean and standard deviation are computed below;

Table 4. Descriptive statistics showing the difference in the mean achievement scores and standard deviation of male and female students in the experimental group.

Group	No of Students	Pre-Test Mean	SD	Post-test Mean	SD	Mean Gain
Male	18	29.15	3.45	45.61	3.21	16.46
Female	27	32.32	2.43	44.75	4.12	12.43
Mean diff.		3.17		0.86		
Total	45					

The table 4 presented data on the mean and standard deviation of academic achievement scores of male and female students in experimental group. Result obtained from the post -test mean score of male in the experimental group is 45.61 while that of the female students had a post-test mean score of 44.75. The higher mean gains of both male and female students in the experimental group showed that there was improvement in the achievement scores of the students.

Research Question Three: What difference exist between retention mean scores of students taught chemistry with differentiated instruction and those taught using conventional method in FCT Abuja. The post post-test mean scores of students in the control and experimental group is computed in the table below to answer the research question.

Table 5: Descriptive statistics showing the difference in the mean retention scores and standard deviation of experimental and control

Group	No of Students	Pre-Test Mean	SD	Post-test Mean	SD	Mean Gain
Experimental	45	55.3	3.8	57.2	8.20	1.9
Control	30	42.2	5.8	35.5	7.80	3.5
Mean diff.		13.1		21.7		1.6
Total	75					

Table 5 presented data on the mean and standard deviation of retention test of students in experimental and control groups. From the result obtained, the mean retention scores of experimental had a mean score of 57.2 while the students in the control group had a mean score of 35.50. The students in the experimental group had a slightly higher mean score compared to the mean score they had in the post test. This implies that they were able to retain knowledge. Further analysis of the results indicated that the mean score of students in the control group dropped from 42.2 to 35.5 which implies that they did not retain as much knowledge as their counterpart in the experimental group.

Research Question Four: What is the possible gender difference in the retention mean scores of male and female students taught chemistry using differentiated instruction in FCT Abuja.

Table 6: Descriptive statistics of difference in the mean retention scores and standard deviation of male and female students in the experimental group.

Group	No of Students	Pre-Test Mean	SD	Post-test Mean	SD	Mean Gain
Male	18	45.61	9.45	48.93	4.87	3.32
Female	27	44.75	11.43	49.45	5.22	4.70
Mean diff.		0.86		0.52		1.38
Total	45					

Table 6 above presented data on the mean and standard deviation of retention scores of male and female students in experimental group. From the analysis of results obtained, the retention mean score of boys in experimental group is 48.93, while the retention mean score of the female students is 49.45. This shows that there was slight improvement in the retention score of male students going by the mean gain of 3.32 obtained. While the female students had a mean gain of 4.70. The difference in the mean retention scores of male and female students is 1.38 in favor of the female students. This implies that the use of differentiated instruction improves the retention ability of both male and female students.

Test of Hypotheses

H_{01}: There is no significant difference between the academic achievement scores of Senior Secondary School Students taught Chemistry with Differentiated Instruction and their counterparts taught using Conventional method.

Analysis of Covariance (ANCOVA) of Post-test Mean scores of Experimental and Control Groups

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2205.869[a]	2	1102.935	107.814	.000	.865
Intercept	3058.765	1	3058.765	298.999	.000	.765

Pretest	8.348	1	8.348	.816	.367	.002
Post-Test	2111.499	1	2111.499	206.402	.000	.313
Error	4623.968	452	10.230			
Total	359752.000	455				
Corrected Total	6829.837	454				

a. R Squared = .323 (Adjusted R Squared = .320)

Table 7 shows the Analysis of Covariance test analysis carried out to determine whether students taught using differentiated instruction and those taught with conventional teaching method differed significantly in their achievement level in chemistry. This analysis of results showed F-value 206.402 for the group (Experimental and Control group) is significant at .000 which is less than 0.05 ($p < .05$). Therefore, the null hypothesis stated was not accepted. Thus, there is a significant difference in the Mean achievement scores of Students taught using differentiated instruction and those taught with conventional method. This implies that students taught with differentiated instruction had higher achievement score than those that were taught with conventional method.

HO_2: There is no significant difference between the academic achievement of male and female students taught chemistry using Differentiated Instruction.

Table 8: Analysis of Covariance (ANCOVA) of Students' Achievement Scores by Gender for Experimental and control

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	101.510[a]	2	50.755	3.410	.034	.615
Intercept	2236.436	1	2006.436	134.790	.000	.710
Pretest	83.327	1	93.327	6.270	.013	.044
Gender	7.140	1	7.140	.480	.489	.001
Error	6518.327	452	14.886			
Total	359752.000	455				
Corrected Total	6829.837	454				

a. R Squared = .015 (Adjusted R Squared = .011)

Table 8 shows the Analysis of Covariance carried out to determine whether male and female Students taught chemistry using differentiated instruction differed significantly in their achievement levels. This test resulted to F-value .480 which is not significant at.489 which is above 0.14 ($p <.05$). The Null hypothesis as formulated was therefore accepted. This implies that there was no significant difference in the Mean achievement scores of Male and Female students taught chemistry using differentiated instruction.

HO_3: There is no significant difference between the retention ability of Senior Secondary School students taught chemistry with Differentiated instruction and those taught using conventional method.

Table 9: Analysis of Covariance (ANCOVA) of Students' Achievement Scores by Gender for Experimental and control

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	99.105[a]	2	49.552	4.057	.018	.0618
Intercept	1711.271	1	1711.271	140.111	.000	.237
Post-	10.090	1	10.090	.826	.364	.002

Retention	88.453	1	77.558	6.350	.002	.014
Error	5520.601	452	12.214			
Total	380657.000	455				
Corrected Total			5619.705	454		

a. R Squared = .015 (Adjusted R Squared = .011)

Table 9 shows the analysis of data carried out to determine whether students taught using DI and those taught with conventional method differed significantly in their mean retention level of 88.453 in chemistry. This test resulted to F-value 6.350 for the group (Experimental and Control group) is significant at .002, which is less than 0.05 ($p < .05$). Therefore, the null hypothesis stated was not accepted. Thus, there is a significant difference in the mean retention level of students taught chemistry using differentiated instruction and those taught using conventional method. This implies that students taught with differentiated instruction had higher retention level than those who were taught using conventional method.

HO_4: There is no significant difference in the retentive ability of male and female students taught chemistry using Differentiated instruction.

Table 10: Analysis of Covariance (ANCOVA) of Students' retention Scores by Gender

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	55.213[a]	2	25.157	1.563	.211	.007
Intercept	3896.027	1	3498.027	217.340	.000	.325
Post-	46.185	1	46.185	2.870	.091	.006
Gender	7.225	1	6.125	.449	.503	.001
Error	7274.821	452	16.095			
Total 367807.000 455 Corrected Total 7325.134 454						

a. R Squared = .007 (Adjusted R Squared = .002)

Table 10 shows the Analysis of Covariance carried out to determine whether male and female students taught using differentiated instruction differed significantly in their retention ability. This test resulted to F-value .449 which is not significant at .503 which is above .005 ($p < 0.05$). The Null hypothesis is hereby retained. This implies that there was no significant difference in the Mean retention ability of Male and Female Students taught chemistry using differentiated instruction.

Discussion of the Findings

Finding of this study revealed that there was difference in the academic achievement scores of students taught chemistry using differentiated instruction compared to their counterparts in the control group. This finding is in line with that of Ahamad, et al., (2021) who investigated the effect of online multiple intelligence-based learning on achievement in motion concept among 10th-grade students. The online multiple intelligence-based learning had a positive effect on achievement in motion concepts, with the mathematical logic and Intrapersonal intelligence group performing significantly better than others do. The study is however, not in agreement with that of Danjuma (2017) who analyzed the impact of a grade 2 social sciences class taught with differentiated instruction on students' academic achievement and retention of knowledge in Gombe State, Nigeria. He found out that both the experimental and control groups showed greater

academic achievement from pre-test to post-test, but students in experimental group demonstrated higher retention ability.

In addition, finding also revealed that the male and female students taught chemistry using differentiated instruction had equal achievement. This agrees to the fact that differentiated instruction is gender friendly, as it enhances the academic achievement of students equally. This finding is in line with that of Njagi (2015) who investigated the effectiveness of differentiated instruction on students' achievement in mathematics by gender. He found that when students were taught using differentiated instruction, gender did not affect their achievement in mathematics. Furthermore, the study agrees with that of Kenni (2020) *who* examined the effects of Advance Organizer teaching strategy on Students' Gender in Secondary School Chemistry in Ekiti State, Nigeria. The study discovered that students achievement in Chemistry was at marginal level before their exposure to expository advance organizer. However, the use of expository advance organizer improves the achievement of students in Chemistry more than conventional method of instruction. Also, it was found that score level and gender classification of students has no influence on their academic achievement when exposed to expository advance organizer.

However, it was discovered that there was significant difference in the retentive ability of students taught using differentiated instruction than their counterpart in the control group. This could be adduced to the efficacy of differentiated instruction in enhancing retention of students in chemistry than the use of conventional. This finding is supported by the study of Brown (2014) that established that students' retention in science seems to improve through the use of some instructional procedure aided models. The results also fit into that of Ogunkunle, et al., (2014) who investigated the effect of differentiated instructional strategies on students' retention in geometry in senior secondary schools and found that students taught geometry using differentiated instruction had higher retention ability than the conventional method. Further analysis of results from the table revealed that there was no significant difference in the retention mean scores of male and female students taught chemistry using differentiated instructional strategy. This finding is in contrast with the study of Bizimana et al (2022) that there was statistically significant gender difference between male and female mean retention scores with females retained significantly higher than males. This implies that the utilization of gender neutral instructional strategies such as differentiated instructional strategy is an effective strategy in enhancing the retention ability of both male and female students in chemistry.

Conclusions

Based on the findings from this study, the following conclusions were made:

i. The study found that differentiated instruction significantly improves students' achievement in chemistry compared to traditional teaching methods. By catering to individual learning styles, this approach helps students better understand and apply key chemistry concepts.

ii. The use of differentiated instruction showed no significant differences in achievement scores between male and female students. This indicates that the teaching strategy is effective for both genders, promoting equitable learning opportunities in chemistry education.

iii. Students taught using differentiated instruction demonstrated higher retention of chemistry concepts over time than those taught with conventional methods. This suggests that engaging and tailored teaching strategies lead to better long-term memory and understanding of the subject.

iv. The absence of gender differences in retention scores among students indicates that differentiated instruction supports consistent learning outcomes across diverse student groups, making it an inclusive educational approach.

Recommendations

i. Teachers should incorporate differentiated instruction techniques into their teaching practices to accommodate diverse learning needs and enhance students' engagement and understanding of chemistry.

ii. Training programs should be organized for chemistry teachers to help them develop skills in differentiated instruction strategies, enabling them to effectively address the varying readiness levels and learning preferences of their students.

iii. Schools should encourage the use of hands-on, practical activities in chemistry lessons, allowing students to actively engage with the content and apply their knowledge in real-world contexts, which can further boost retention.

iv. Educators should employ varied assessment methods to monitor students' progress continuously, providing timely feedback that aligns with their individual learning styles and needs to foster improvement and academic success.

Implications of Findings.

i. Future studies should explore the effectiveness of differentiated instruction in other science subjects, beyond chemistry, to assess its general applicability and impact on diverse learning areas.

ii. Further research should investigate which components of differentiated instruction—such as tiered assignments or flexible grouping most effectively enhance student achievement and retention.

iii. Future studies should explore how differentiated instruction influences students' attitudes toward chemistry and their interest in pursuing careers in STEM fields.

iv. Research should examine the impact of differentiated instruction in varied educational contexts, including different school types and resource settings, to better understand its scalability and effectiveness in diverse environments.

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