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EFFECTS OF DIFFERENTIATED AND BLENDED INSTRUCTIONAL STRATEGIES ON STUDENTS' INTEREST AND ACHIEVEMENT OF CHEMICAL COMBINATION IN BWARI, ABUJA, NIGERIA

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Abstract

This study investigated the effects of differentiated and blended instructional strategies on students' interest and achievement in chemical combination in Bwari Area Council, Abuja, Nigeria. Two research questions were raised, and two null hypotheses were formulated and tested at the 0.05 level of significance. A quasi-experimental design with a pretest, posttest, and a control group was adopted. The population comprised 1,290 Senior Secondary One (SS1) chemistry students in public secondary schools in Bwari, Federal Capital Territory, Abuja. A sample of 158 students was selected using simple random sampling. Three intact classes from three schools were used, with two assigned to experimental groups and one to a control group. Two instruments were used for data collection: the Chemical Combination Interest Rating Scale (CCIRS) and the Chemical Combination Achievement Test (CCAT). Experts validated the instruments. Reliability coefficients of 0.84 for CCAT using Kuder-Richardson 21 and 0.81 for

CCIRS using Cronbach's Alpha were obtained. Data were analyzed using means and standard deviations, and ANCOVA was used to test hypotheses at the 0.05 significance level. Bonferroni post hoc analysis determined the direction of differences. Findings revealed that students taught using differentiated and blended instructional strategies had significantly higher interest and academic achievement in chemical combination than those taught using the conventional method. The study concludes that both instructional strategies are effective in improving students' interest and achievement in chemical combination. It is recommended that chemistry teachers adopt differentiated instruction to address learners' diverse needs and integrate blended learning approaches to enhance active participation and understanding of abstract chemistry concepts.

Keywords: Differentiated instruction, Blended learning, Chemical Combination, Students' Interest, and Students' Achievement.

Introduction

Rapid technological advancement characterizes the era of globalization, with increased smartphone use and internet access, particularly among secondary school students (Suleiman et al., 2017; Elok & Slamet, 2019). This growing integration of technology into society has influenced the education sector, where educators increasingly adopt digital tools to enhance teaching and learning, given their perceived effectiveness compared to traditional methods (Klu et al., 2021). Technological development also serves as a key indicator of national progress, highlighting the need to strengthen science education in developing countries such as Nigeria (Obikezie et al., 2021).

Science plays a vital role in national development by promoting curiosity, critical thinking, and problem-solving skills, while contributing significantly to sectors such as medicine, engineering, and education (Ziman, 2019; Abimbola, 2013). As an interdisciplinary field, science includes subjects such as Biology, Physics, and

Chemistry, with chemistry often regarded as the central science due to its role in explaining the composition, structure, and transformation of matter (Bagley, 2017; Biswas, 2020; Nwafor et al., 2022). In Nigeria, chemistry is a core subject at the senior secondary level and a prerequisite for science-based courses in tertiary institutions. However, students' achievement in chemistry at the Senior Secondary School Certificate Examination (SSCE) has remained consistently poor (Njoku, 2017; Imasuen & Ebuwa, 2023).

This persistent underachievement has been attributed to several factors, including ineffective teaching methods, poor subject mastery, inadequate laboratory experiences, and students' difficulty in understanding abstract concepts (Ngeme, 2016; Odhiambo, 2016; Suleiman et al., 2017; Edem & Anari, 2021; Falode & Onasanya, 2015; Gourish et al., 2018). Reports from the West African Examinations Council (WAEC) further highlight students' weaknesses in areas such as chemical calculations, bonding concepts,

and the application of theoretical knowledge to practical situations. In particular, chemical combination, which involves concepts such as ionic and covalent bonding, has been identified as one of the abstract areas contributing to students' poor performance. The persistent low achievement recorded in chemistry between 2017 and 2024 (WAEC, 2024) underscores the need for more effective instructional strategies. Therefore, improving students' interest and achievement in chemical combination requires adopting innovative, learner-centered, and technology-supported teaching approaches. As reported by the WAEC Research and Statistics Unit from 2017-2024, a trend of low achievement of students in chemistry was revealed, as shown in Table 1.

Table 1: Achievement of Chemistry Students in May/June WAEC Senior Secondary Certificate Examination 2017-2024

Year	Number that sat for the Examination	Number with pass with credit	% Pass with credit	% Failure
2017	691,467	229,731	31.86	68.14
2018	667,412	336,770	42.89	57.11
2019	04,494	323,320	41.56	58.41
2020	728,99	275,593	40.61	59.90
2021	699,196	224,512	32.11	67.59
2022	701,291	309,339	44.11	55.89
2023	698,440	271,693	38.90	61.10
2024	701,290	231,565	33.02	66.98

Source: WAEC Research and Statistics unit, Annual WAEC Report 2024, Lagos

Table 1.1 illustrates the consistently low achievement of students in chemistry in WAEC examinations from 2017 to 2023. This persistent problem of poor achievement in chemistry at the secondary school level has been attributed to several factors, including inadequate teaching materials and equipment, a shortage of qualified teachers, low student interest, and ineffective instructional methods. Consequently, greater attention has been directed toward improving teaching strategies for complex and abstract concepts such as chemical combination

(Obikezie et al., 2021; Gourish, Palash, & Madhulika, 2018).

Chemical combination forms the foundation upon which the entire field of chemistry is built. It is a fundamental concept that explains how elements with distinct properties combine to form new substances through chemical reactions. Understanding this concept is essential not only for students of chemistry but also for all learners, as it provides insights into the composition of matter and the transformative role of chemistry in everyday life (Obikezie et al., 2021). Beyond its theoretical relevance, chemical combination has practical applications in areas such as water quality and drug development. For instance, chemicals present in water samples can induce oxidative stress responses (Escher et al., 2013). Given its importance, this concept must be taught using effective instructional strategies that can enhance students' interest, achievement, and retention, such as differentiated and blended instructional approaches.

Differentiated instruction is a teaching approach that provides learners with multiple pathways for understanding content and processing ideas. It is based on the premise that instructional methods should be adapted to accommodate students' diverse needs, abilities, and learning styles (Tomlinson, 2014). Studies have shown that differentiated instruction promotes the use of varied teaching strategies tailored to students' characteristics and is considered an effective and learner-centered method (Deringöl & Davasligil, 2019; Olçay Gül, 2014; Beler & Avcı, 2016; Ogunkunle & Onwunedo, 2014). This approach enhances students' active participation, supports independent learning, and helps bridge differences in learners' abilities. By carefully considering students' characteristics and instructional content (Tomlinson & Moon, 2015), teachers can better address individual learning needs and improve overall learning outcomes (Obafemi, 2022).

Blended learning, on the other hand, combines face-to-face instruction with online

components, creating a flexible, interactive learning environment. It integrates technological innovations with traditional classroom interaction to enhance learning experiences. Thorne (2013) described blended learning as an approach that combines technological advancement with traditional methods to meet diverse learning needs. Similarly, Tara and Bindu (2016) defined it as the integration of online content delivery with classroom interaction to support personalized learning. Gourish, Palash, and Madhulika (2018) further emphasized that blended learning strategically combines different teaching models to improve both face-to-face and online learning experiences. According to Oriji and Nnadiyeze (2023), blended learning involves combining different forms of learning, including physical and virtual, formal and informal, and scheduled and self-paced learning, ensuring that both traditional and online components are effectively integrated.

However, a simplistic application of blended learning, where online elements are merely added to traditional instruction without thoughtful integration, may not yield meaningful results. Effective blended learning requires intentional design and implementation to enhance students' understanding of abstract concepts such as chemical combination. The integration of face-to-face instruction with online platforms (e.g., Google Classroom, Zoom) can improve students' interest, achievement, and retention in chemistry.

Students' interests play a crucial role in influencing their academic achievement and retention. Interest reflects learners' attitudes, engagement, and motivation toward a subject, and it significantly affects learning outcomes. Engaging students through effective instructional strategies can facilitate better understanding and long-term retention of knowledge. Therefore, exploring innovative teaching methods that enhance students' interest in chemical combinations is essential.

Academic achievement refers to the level of success students attain in meeting educational objectives at a given time. It serves as an indicator of students' understanding and mastery of subject content (Adeyemi, 2018). However, students' low achievement in chemical combination has been linked to factors such as inadequate content coverage, poor study habits, negative attitudes toward chemistry, and limited access to learning resources (Suleiman et al., 2017; Edem & Anari, 2021). These challenges hinder students' ability to retain and apply learned concepts effectively. It is against this background that the researcher intends to investigate the Effects of differentiated and blended instructional strategies on students' interest and achievement of chemical combination in Bwari, Abuja, Nigeria.

Statement of the Problem

The teaching and learning of chemistry in secondary schools has remained a major concern due to the abstract nature of many of its concepts, particularly chemical

combination. This has contributed to the persistent poor performance of students in the Senior Secondary Certificate Examination (SSCE) in Nigeria. Despite the introduction of various instructional approaches to improve students' learning outcomes, examination reports continue to indicate low achievement in chemistry. One major factor responsible for this trend is the continued reliance on conventional teacher-centered instructional methods, which often fail to address students' diverse learning needs and do not adequately support the understanding of abstract concepts such as ionic and covalent bonding. Consequently, many students struggle to comprehend chemical combinations, leading to low interest, poor achievement, and weak retention of learned concepts.

Given the importance of chemical combination as a foundational topic in chemistry, there is a growing need to adopt innovative, learner-centered instructional strategies that enhance students' engagement and understanding. Differentiated

instruction, which accommodates learners' individual differences, and blended learning, which integrates face-to-face and technology-mediated instruction, have shown potential in improving students' learning outcomes. However, there is limited empirical evidence on the combined effect of these instructional strategies on students' interest, achievement, and retention in chemical combination, particularly within the context of the Bwari Area Council, Abuja. Therefore, this study investigates the effects of differentiated and blended instructional strategies on students' interest, achievement, and retention in chemical combination among secondary school students in Bwari, Abuja, Nigeria.

Objectives of the Study

The purpose of this study was to investigate the Effects of differentiated and blended instructional strategies on students' interest and achievement in chemical combination in Bwari, Abuja, Nigeria. The study sought to achieve the following specific Objectives:

1. Investigate the effect of differentiated and blended instructional strategies on students' interest in chemical combination.
2. Ascertain the effect of differentiated and blended instructional strategies on students' achievement in chemical combination.

Research Questions

The following research questions guided the study:

1. What are the mean interest ratings of students taught Chemical combination using differentiated strategy, blended instructional strategies and those taught using Conventional method?
2. What are the mean achievement scores of students taught Chemical combination using differentiated and blended instructional strategies and those taught using the conventional method?

Statement of hypotheses

The following research hypotheses were formulated to guide the study and were tested at 0.05 level of significance.

H₀₁: There is no significant difference in the mean interest ratings of students

taught Chemical combination using differentiated strategies, blended instructional strategies and Conventional method.

Ho₄: There is no significant difference in the mean achievement scores of students taught Chemical combination using differentiated and, blended instructional strategies and Conventional method.

Methodology

The study adopted a quasi-experimental pretest-posttest, delayed posttest non-equivalent control-group design. This design was considered appropriate because intact classes were used, making random assignment of individual students to treatment conditions impractical. The study involved two experimental groups, each exposed to differentiated or blended instructional strategies, and a control group taught using the conventional method.

The population comprised 1,195 Senior Secondary One (SS1) chemistry students from public secondary schools in Bwari Area Council, Abuja. A sample of 158 students

was selected using a multi-stage sampling procedure. Ten schools offering chemistry were initially identified, from which three were randomly selected. The selected schools were then assigned to the experimental and control groups by ballot, and intact classes served as the study sample.

Two instruments were used for data collection: the Chemical Combination Interest Rating Scale (CCIRS) and the Chemical Combination Achievement Test (CCAT). The CCIRS consisted of 20 items on a four-point Likert scale to measure students' interest. At the same time, the CCAT comprised 30 multiple-choice questions drawn from past SSCE examinations and structured based on Bloom's taxonomy. Experts validated the instruments, and reliability coefficients of 0.81 (CCIRS) and 0.84 (CCAT) were obtained using Cronbach's Alpha and Kuder-Richardson (KR-21), respectively.

Data collection was carried out in four phases: pretest, treatment, posttest, and delayed posttest. The treatment lasted four

weeks, during which the experimental groups were taught using differentiated and blended instructional strategies, while the control group received conventional instruction. The delayed posttest was conducted two weeks after the posttest to assess retention.

Data were analyzed using means and standard deviations to answer research

questions, and Analysis of Covariance (ANCOVA) was used to test hypotheses at the 0.05 level of significance, with pretest scores as covariates. A Bonferroni multiple-comparison analysis was further employed to determine the direction of differences among the groups.

Results

Research Question One: What are the mean interest ratings of students taught Chemical combination using differentiated strategy, blended instructional strategy and those taught using Conventional method?

Table 2: Mean and Standard Deviation of Interest Ratings of Students Taught Chemical Combination Using Differentiated, Blended Learning Strategies and Conventional Method

Group		PreInterest	PostInterest
Differentiated Learning Strategy (E1)	Mean	42.63	59.04
	N	56	56
	Std. Deviation	6.375	7.393
Blended Learning Strategy (E2)	Mean	49.04	56.62
	N	50	50
	Std. Deviation	5.462	5.022
Control Group (CG)	Mean	40.77	49.42
	N	52	52
	Std. Deviation	7.366	4.151

Table 2 shows the pre-interest and post-interest mean ratings and standard deviations of students exposed to different instructional strategies. The pre-interest mean rating and standard deviation for students taught using

the Differentiated Learning Strategy (E1) were 42.63 and 6.38, respectively, while the post-interest mean rating and standard deviation were 59.04 and 7.39, respectively. For students taught using the Blended

Learning Strategy (E2), the pre-interest mean rating and standard deviation were 49.04 and 5.46, respectively, while the post-interest mean rating and standard deviation were 56.62 and 5.02, respectively. In the Control Group (CG), students had a pre-interest mean and standard deviation of 40.77 and 7.37, respectively, and a post-interest mean and standard deviation of 49.42 and 4.15, respectively.

Hypothesis One: There is no significant difference in the mean interest ratings of students taught Chemical combination using differentiated strategies, blended instructional strategies and Conventional method.

Table 3: Results of Analysis of Covariance on Students' Interest Ratings Taught Chemical Combination Using Differentiated Strategy, Blended Instructional Strategy, and Conventional Method

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3110.899 ^a	3	1036.966	34.208	.000	.400
Intercept	6105.564	1	6105.564	201.414	.000	.567
PreInterest	452.129	1	452.129	14.915	.000	.088
Group	2213.168	2	1106.584	36.505	.000	.322
Error	4668.272	154	30.313			
Total	487601.000	158				
Corrected Total	7779.171	157				

a. R Squared = .400 (Adjusted R Squared = .388)

Table 3 reveals a significant difference in the mean interest ratings among students exposed to the differentiated, blended, and conventional instructional strategies. An F-value of $F_{(2, 154)} = 36.505$ was obtained with an associated exact probability value of 0.000. Since the associated probability (0.000) is less than 0.05 level of significance, the null hypothesis was rejected. Hence, there was a significant difference among the three groups: differentiated, blended, and the control group. Based on the established difference in the groups' interest ratings, Bonferroni Multiple Comparisons was used to determine the direction of the difference. The results of this analysis are shown in Table 4.

Table 4: Bonferroni Multiple Comparisons Results of Students' Mean Interest Ratings Exposed to Differentiated Instructional Strategy, Blended Instructional Strategy, and Conventional Method

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig. ^b	95% Confidence Interval for Difference ^b	
					Lower Bound	Upper Bound
EG1	EG2	4.112*	1.158	.002	1.310	6.915
	CG	9.122*	1.068	.000	6.537	11.707
EG2	EG1	-4.112*	1.158	.002	-6.915	-1.310
	CG	5.010*	1.229	.000	2.035	7.984
CG	EG1	-9.122*	1.068	.000	-11.707	-6.537
	EG2	-5.010*	1.229	.000	-7.984	-2.035

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Table 4 shows a significant difference in mean interest ratings between students exposed to the differentiated instructional strategy (EG1) and those exposed to the blended instructional strategy (EG2). Since the associated probability (0.002) is less than 0.05 level of significance, the null hypothesis was rejected in favour of EG1.

A significant difference was observed in the mean interest ratings between students exposed to differentiated instructional

strategy (EG1) and the control group (CG). Since the associated probability (0.000) is less than the 0.05 level of significance, the null hypothesis was rejected. Likewise, a significant difference in mean interest ratings was observed between students exposed to the blended instructional strategy (EG2) and the control group (CG). Since the associated probability (0.000) is less than the 0.05 level of significance, the null hypothesis was rejected.

Research Question Two: What are the mean achievement scores of students taught Chemical combination using differentiated strategy, blended instructional strategy and those taught using Conventional method?

Table 5: Mean and Standard Deviation of Achievement Scores of Students Taught Chemical Combination Using Differentiated, Blended, and Conventional Instructional Strategies

Group	Pretest	Posttest
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EG1	Mean	8.86	23.23
	N	56	56
	Std. Deviation	2.300	2.991
EG2	Mean	10.46	20.24
	N	50	50
	Std. Deviation	2.052	3.335
CG	Mean	7.77	17.46
	N	52	52
	Std. Deviation	1.996	3.153

Table 5 shows the pretest and posttest mean achievement scores and standard deviations for students taught using the Chemical Combination with Differentiated Instructional Strategy (EG1), the Blended Instructional Strategy (EG2), and the Conventional Method (CG). Students in EG1 had a pretest mean score of 8.86, a standard deviation of 2.30, and a posttest mean of 23.23 and a standard deviation of 2.99. Students in EG2 had a pretest mean of 10.46 and a standard deviation of 2.05, which rose to a posttest mean of 20.24 and a standard deviation of 3.34. Students in the Control Group had a pretest mean of 7.77 and a standard deviation of 2.00, and a posttest mean of 17.46 and a standard deviation of 3.15.

Hypothesis Two: There is no significant difference in the mean achievement scores of students taught Chemical combination using the differentiated strategy, blended instructional strategy, and the conventional method.

Table 6: Result of Analysis of Covariance of Students' Achievement Scores Taught Chemical Combination Using Differentiated Strategy, Blended Instructional Strategy, and Conventional Method

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	899.446 ^a	3	299.815	29.904	.000	.368
Intercept	3345.320	1	3345.320	333.665	.000	.684
Pretest	.021	1	.021	.002	.963	.000
Group	871.438	2	435.719	43.459	.000	.361
Error	1544.004	154	10.026			
Total	68107.000	158				
Corrected Total	2443.449	157				

a. R Squared = .368 (Adjusted R Squared = .356)

Table 6 reveals a significant difference in the mean achievement scores of students exposed to the differentiated, blended, and conventional instructional strategies. An F-value of $F_{(2, 154)} = 43.459$ was obtained with an associated exact probability value of 0.000. Since the associated probability (0.000) is less than the 0.05 level of significance, the null hypothesis was rejected. This result indicates that students' achievement in Chemical Combination varied significantly across instructional strategies. Based on the established difference in the mean achievement scores of the groups, Bonferroni Multiple Comparisons was used to determine the direction of the difference. The results of this analysis are shown in Table 4.10.

Table 7: Bonferroni Multiple Comparisons Results of Mean Students' Achievement Scores Taught Chemical Combination Using Differentiated Strategy, Blended Instructional Strategy, and Conventional Method

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig. ^b	95% Confidence Interval for Difference ^b	
					Lower Bound	Upper Bound
EG1	EG2	3.001*	.645	.000	1.439	4.563
	CG	5.765*	.624	.000	4.255	7.274
EG2	EG1	-3.001*	.645	.000	-4.563	-1.439
	CG	2.764*	.705	.000	1.057	4.470
CG	EG1	-5.765*	.624	.000	-7.274	-4.255
	EG2	-2.764*	.705	.000	-4.470	-1.057

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Table 7 shows the Bonferroni multiple comparisons of students' mean achievement scores across the three instructional groups: Differentiated Instructional Strategy (EG1), Blended Instructional Strategy (EG2), and Conventional Method (CG).

In the case of EG1 (Differentiated) and EG2 (Blended): The mean difference was 3.001 with a p-value of 0.000, indicating that students taught using the differentiated strategy achieved significantly better than those taught using the blended strategy.

For EG1 (Differentiated) and CG: The mean difference was 5.765 ($p=0.000$), indicating a

Discussions

The findings revealed a significant difference in the mean interest ratings among students exposed to the differentiated, blended, and conventional instructional strategies. This indicates that students taught with differentiated and blended instructional strategies showed higher levels of interest than those taught with the conventional method. This finding aligns with the results of Anakpua, Nzeakor, and Emefo (2021),

significant advantage of the differentiated strategy over the conventional method. For EG2 (Blended) and CG, the mean difference was 2.764 ($p=0.000$), indicating that students exposed to the blended strategy also performed significantly better than those in the conventional group.

The differentiated instructional strategy (EG1) was the most effective, followed by the blended strategy (EG2), with the conventional method (CG) being the least effective in enhancing students' achievement in Chemical Combination.

who found that differentiated instruction significantly enhanced students' achievement in chemical combination. Similarly, Edem and Anari (2021) and Anari (2021) reported that blended instructional strategies improved students' interest and achievement in chemistry, highlighting the positive influence of interactive, technology-integrated teaching approaches on learners' motivation. The higher interest observed among students exposed to differentiated

instruction can be attributed to its ability to address individual learning needs, preferences, and readiness levels. Differentiated instructional strategies provide multiple pathways for learning, including varied instructional materials, activities, and assessment methods, allowing students to engage with content actively at their own pace. By accommodating differences in students' cognitive levels, learning styles, and prior knowledge, differentiated instruction promotes a sense of autonomy, competence, and relevance in learning, which are crucial factors for sustaining interest (Igbo & Solomon, 2021; Abuhmaid, 2018).

Blended instructional strategy also contributed to elevated interest levels, consistent with findings by Klu, Ameyaw, and Hordzi (2021) and Salisu (2021), who observed that the combination of face-to-face instruction and digital learning tools increased students' achievement. The use of multimedia resources, simulations, interactive exercises, and collaborative

platforms in blended learning provides varied stimuli that sustain curiosity and attention while allowing students to interact with content and peers in meaningful ways. This approach encourages active learning, immediate feedback, and repeated practice, which are known to enhance intrinsic motivation and cognitive involvement. In contrast, students taught using the conventional method showed lower interest ratings, reflecting the passive, teacher-centered nature of this approach. As reported by Adamu and Zakari (2020) and Firas (2019), conventional teaching often limits opportunities for student engagement, critical thinking, and personalized learning, thereby reducing learners' motivation and interest in the subject matter. Students in such settings are likely to perceive learning as routine and less stimulating, which can negatively affect both engagement and academic outcomes.

The findings revealed a significant difference in the mean achievement scores of students exposed to the differentiated, blended, and conventional instructional strategies. This

indicates that the instructional approach had a significant effect on students' learning outcomes in Chemical Combination, with students taught using differentiated and blended strategies performing differently from their counterparts taught using the conventional method. This finding aligns with the findings of Abdullahi and Gana (2024), Adeyemi and Olagunju (2022), and Chukwunenye (2022), who reported that student-centered and technology-enhanced instructional strategies significantly improve students' achievement in science subjects compared to conventional teaching. Conversely, studies by Otuka, Uzoechi, and Ejimonu (2018) and Pember and Achor (2017) found that conventional teacher-centered methods were more effective for certain learners, suggesting that instructional strategy effectiveness may depend on learners' prior knowledge, learning preferences, and levels of engagement.

Differentiated instruction enhances achievement by tailoring content, process, and learning activities to meet individual

students' readiness levels, interests, and learning profiles. This personalized approach allows learners to engage with concepts at their own pace, promotes deeper understanding, and fosters critical thinking and problem-solving skills. Similarly, blended instructional strategy integrates online resources, multimedia, and collaborative tasks with face-to-face teaching, providing multiple avenues for students to access content, interact with peers, and receive immediate feedback. This combination of flexibility, interactivity, and guided instruction strengthens comprehension and retention of chemical concepts.

Conclusion

The study concludes that differentiated and blended instructional strategies are more effective than the conventional teaching method in enhancing students' interest and achievement in chemical combination among secondary school students in Bwari Area Council, Abuja. Students exposed to these instructional approaches demonstrated

higher engagement and better academic achievement than those taught using the conventional method.

The study also establishes that differentiated and blended instructional strategies improve students' understanding of chemical combinations by promoting active participation, individualized learning, and the use of supportive instructional resources. These approaches effectively simplify abstract concepts, thereby increasing students' interest and enhancing their academic achievement. In conclusion, adopting learner-centered, technology-integrated instructional strategies is essential for improving students' learning outcomes in chemistry, particularly in abstract topics such as chemical combination.

Recommendations

In light of the findings of this study, it was recommended that:

1. Science teachers should use differentiated instructional strategies to address students' individual

learning needs, enhance engagement, and improve retention in Chemical Combination.

2. Teachers and school administrators should adopt blended instructional approaches that combine face-to-face and digital learning tools to promote active participation and sustained interest among all students.
3. Curriculum planners and policymakers should provide technology-enhanced teaching resources, such as computers and projectors, to support blended and differentiated instruction and improve understanding and achievement in chemical combination.

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