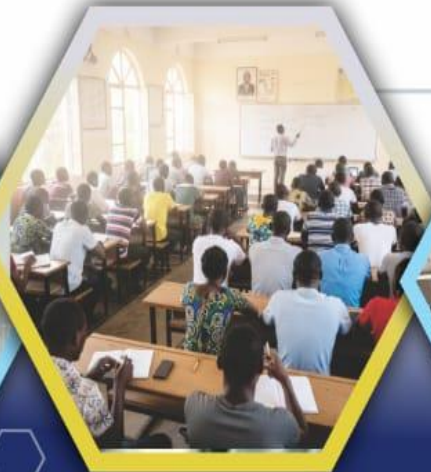




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GENDER AS A DETERMINANT OF STUDENTS' INTEREST AND ACHIEVEMENT IN CHEMICAL COMBINATION TAUGHT USING DIFFERENTIATED AND BLENDED INSTRUCTIONAL STRATEGIES IN BWARI, ABUJA, NIGERIA

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Abstract

This study investigated gender as a determinant of students' interest and achievement in chemical combination when taught using differentiated and blended instructional strategies in Bwari Area Council, Abuja, Nigeria. A quasi-experimental design involving pre-test and post-test with non-equivalent control groups was adopted. The population comprised 1,195 Senior Secondary One (SS1) chemistry students, from which a sample of 158 students (87 males and 71 females) was selected using a multi-stage sampling technique. Three intact classes from selected schools were assigned to two experimental groups (differentiated and blended instructional strategies) and one control group (conventional method). Two instruments were used for data collection: the Chemical Combination Interest Rating Scale (CCIRS) and the Chemical Combination Achievement Test (CCAT). The instruments were validated by experts and yielded reliability coefficients of 0.81 and 0.84, respectively. Data were analyzed using means and standard deviations to answer the

research questions, and Analysis of Covariance (ANCOVA) was used to test the hypotheses at the 0.05 level of significance. Findings revealed that gender significantly influenced students' interest and achievement when taught using differentiated instructional strategy. Gender also significantly influenced students' interest in the blended instructional strategy; however, it did not significantly influence achievement under the same approach. The study concludes that while differentiated instruction may produce gender-based variations in learning outcomes, blended instructional strategy promotes more balanced academic achievement across genders. The study recommends the adoption of differentiated and blended instructional strategies in chemistry teaching, alongside efforts to ensure gender-inclusive classroom practices that enhance students' interest and achievement in chemical combination.

Keywords: Gender, Students' Interest, Academic Achievement, Chemical Combination, Differentiated Instruction, and Blended Learning.

Introduction

Science education plays a crucial role in national development, as it equips learners with the knowledge, skills, and competencies required for technological advancement and problem-solving in everyday life. Among the science subjects, chemistry occupies a central position due to its relevance in explaining the composition, structure, and transformation of matter. In Nigeria, chemistry is a core subject at the senior secondary school level and serves as a prerequisite for admission into many science-based courses in tertiary institutions. Despite its importance, students' academic achievement in chemistry, particularly in external examinations such as the Senior Secondary School Certificate Examination (SSCE), has remained persistently low over the years (Njoku, 2017; Imasuen & Ebuwa, 2023).

One of the major areas of difficulty in chemistry is chemical combination, which involves abstract concepts such as ionic and covalent bonding. These concepts require high-level cognitive processing and often pose significant challenges for students, leading to poor understanding, low interest, and weak academic performance. Reports from examination bodies such as the West African Examinations Council (WAEC) have consistently highlighted students' poor performance in this aspect of chemistry,

indicating the need for more effective and innovative teaching approaches. Traditional teaching methods, which are often teacher-centered and rely heavily on rote memorization, have been identified as inadequate for addressing students' diverse learning needs and for promoting meaningful understanding of abstract scientific concepts.

In response to these challenges, educators have increasingly advocated adopting learner-centered instructional strategies, such as differentiated instruction and blended learning. Differentiated instruction involves tailoring teaching methods, learning activities, and assessment strategies to accommodate students' varying abilities, interests, and learning styles (Tomlinson, 2014). This approach promotes inclusivity and ensures that all learners are actively engaged in the learning process. On the other hand, blended learning integrates face-to-face classroom instruction with digital and online learning resources, creating a more flexible and interactive learning environment. The use of technological tools such as virtual simulations, videos, and online discussions can enhance students' understanding of complex concepts, such as chemical combination, and improve their overall learning experience.

Gender can be a significant factor in examining student achievement across

academic subjects, including chemistry. Research studies have examined the relationship between gender and achievement in chemistry, shedding light on potential differences between male and female students. Gambari, Obielodan, and Kawu (2017) investigated the effects of a virtual laboratory on achievement levels and gender in secondary school chemistry students in Minna, using both individualized and collaborative settings. The researchers found that while there were no significant differences in overall achievement between male and female students, there were variations in specific areas of the chemistry curriculum. Female students tended to perform better in organic chemistry, while male students showed higher achievement in physical and inorganic chemistry. Another study by Zhang, Tsang, Wang, and Liu (2022) investigated the gender differences in high school students' chemistry achievement. The results indicated that female students outperformed male students in chemistry achievement. While these instructional strategies have shown promise in improving students' interest and academic achievement, there is growing concern about the role of gender in influencing learning outcomes. Gender, as a socio-cultural construct, shapes individuals' experiences, attitudes, and participation in educational settings. Studies have indicated that male and female students may differ in their interest, engagement, and

achievement in science subjects due to factors such as societal expectations, classroom interactions, and access to learning opportunities (Nworgu, 2015). In some cases, male students have been found to outperform their female counterparts in science-related tasks. At the same time, other studies report no significant difference or even better performance among female students, suggesting that gender disparities in education are context-dependent.

Furthermore, the interaction between gender and instructional strategies warrants further investigation. Innovative approaches such as differentiated instruction and blended learning may help bridge gender gaps by providing equal opportunities for participation and accommodating diverse learning preferences. For instance, differentiated instruction allows teachers to design activities that appeal to both male and female learners. At the same time, blended learning offers flexible access to learning materials, enabling students to learn at their own pace. However, without empirical evidence, it remains unclear whether these strategies are equally effective for both genders in enhancing interest and achievement in chemical combination.

In Bwari Area Council of the Federal Capital Territory, Abuja, where this study is situated, the issue of students' poor performance in

chemistry persists despite ongoing efforts to improve science education. There is therefore a need to explore not only effective instructional strategies but also how these strategies interact with gender to influence learning outcomes. Understanding whether gender plays a significant role in determining students' interest and achievement when exposed to differentiated and blended instructional strategies will provide valuable insights for educators, curriculum planners, and policymakers. It is against this background that this study seeks to investigate gender as a determinant of students' interest and academic achievement in chemical combination when taught using differentiated and blended instructional strategies in Bwari, Abuja, Nigeria.

Statement of the Problem

The teaching of chemistry in secondary schools remains challenging due to the abstract nature of topics like chemical combination, contributing to students' persistent poor performance in examinations such as the SSCE in Nigeria. This problem is largely linked to the continued use of teacher-centered instructional methods, which fail to address diverse learning needs and make it difficult for students to understand concepts such as ionic and covalent bonding, leading to low interest and poor achievement. In addition, gender has been identified as an

important factor influencing students' interest and achievement in chemistry. Differences in how male and female students engage with the subject suggest that learning outcomes may vary depending on classroom practices and the nature of instruction. While some studies indicate higher performance among male students, others show that female students can achieve equally well in supportive learning environments.

Instructional strategies such as differentiated instruction and blended learning offer potential to address these challenges by accommodating diverse learners and promoting active engagement for both genders. However, there is limited evidence on how gender interacts with these strategies in influencing students' interest and achievement in chemical combination. Therefore, this study investigates gender as a determinant of students' interest and achievement when taught using differentiated and blended instructional strategies in Bwari, Abuja, Nigeria.

Objectives of the Study

The purpose of this study is to investigate gender as a determinant of students' interest and achievement in chemical combination taught using differentiated and blended instructional strategies in Bwari, Abuja, Nigeria. The study sought to achieve the following specific Objectives:

1. determine the influence of gender on students' interest in chemical combinations when taught using differentiated instructional strategy.
2. Find out the influence on gender on students' interest in chemical combinations when taught using blended instructional strategy.
3. determine the influence of gender on students' achievement in chemical combinations when taught using differentiated instructional strategy.
4. Determine the influence on gender on students' achievement in chemical combinations when taught using blended instructional strategy.

Research Questions

The following research questions guided the study:

1. What are the mean interest ratings of male and female students taught Chemical combination using differentiated instructional strategy?
2. What are the mean interest ratings of male and female students taught Chemical combination using blended instructional strategy?
3. What are the mean achievement scores of male and female students taught Chemical combination using differentiated instructional strategy?

4. What are the mean achievement scores of male and female students taught Chemical combination using blended instructional strategy?

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 male and female students taught Chemical combination using differentiated instructional strategy.

H₀₂: There is no significant difference in the mean interest ratings of male and female students taught Chemical combination using blended strategy.

H₀₃. There is no significant difference in the mean achievement scores of male and female students taught Chemical combination using differentiated instructional strategy

H₀₄: There is no significant difference in the mean achievement scores of male and female students taught Chemical combination using blended strategy

Methodology

This study employed a quasi-experimental design with a pre-test and post-test and a non-equivalent control group structure comprising two experimental groups and one

control group. The experimental groups received instruction through differentiated and blended teaching strategies, while the control group was taught using the conventional method. This design was deemed suitable because it used intact classes, which prevented random assignment of individual students. The population comprised 1,195 Senior Secondary One (SS1) chemistry students in public secondary schools in Bwari Area Council, Abuja. A sample of 158 (87 males and 71 females) students was selected from three randomly chosen schools using a multi-stage sampling technique. Intact classes from the selected schools were assigned to experimental and control groups.

Two instruments were used for data collection: the Chemical Combination

Interest Rating Scale (CCIRS) and the Chemical Combination Achievement Test (CCAT). The CCIRS measured students' interest using a 4-point Likert scale, while the CCAT consisted of 30 multiple-choice items drawn from SSCE questions and structured across Bloom's taxonomy levels. Both instruments were validated by experts and tested for reliability, yielding coefficients of 0.81 for CCIRS and 0.84 for CCAT.

Data were collected in four phases: pre-test, a four-week treatment period, post-test, and delayed post-test. The instruments were administered by the researcher with trained research assistants. Data were analyzed using means and standard deviations to answer research questions, and ANCOVA was used to test hypotheses at 0.05 significance level, controlling for initial group differences.

Result

Research Question One: What are the mean interest ratings of male and female students taught Chemical combination using differentiated instructional strategy?

Table 1: Mean and Standard Deviation of Interest Ratings of Male and Female Students Taught Chemical Combination Using Differentiated Instructional Strategy

Gender	EG1	PreInterest	PostInterest
Male	Mean	45.17	64.63
	N	30	30
	Std. Deviation	5.902	4.279
Female	Mean	39.69	52.58
	N	26	26
	Std. Deviation	5.683	4.244

Table 1 shows the pre- and post-interest mean ratings and standard deviations for male and female students taught Chemical Combination using the Differentiated

Instructional Strategy (EG1). Male students had pre-interest mean ratings of 45.17 (SD = 5.90) and post-interest mean ratings of 64.63 (SD = 4.28). Female students had a pre-interest mean rating of 39.69 and a standard deviation of 5.68, and a post-interest mean rating of 52.58 with a standard deviation of 4.24.

Hypothesis One: There is no significant difference in the mean interest ratings of male and female students taught Chemical combination using differentiated instructional strategy

Table 2: Result of Analysis of Covariance of Male and Female Students' Interest Ratings Taught Chemical Combination Using Differentiated Instructional Strategy

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2026.135 ^a	2	1013.068	54.800	.000	.674
Intercept	3550.192	1	3550.192	192.041	.000	.784
PreInterest	1.519	1	1.519	.082	.775	.002
GenderEG1	1690.022	1	1690.022	91.418	.000	.633
Error	979.794	53	18.487			
Total	198178.000	56				
Corrected Total	3005.929	55				

a. R Squared = .674 (Adjusted R Squared = .662)

Table 2 reveals a significant difference in the mean interest ratings between male and female students exposed to a differentiated instructional strategy. An F-value of $F_{(1, 53)} = 91.418$ 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 implies that male and female students differed significantly in their interest ratings when taught Chemical Combination using differentiated instructional strategy. In other words, gender had a significant effect on students' interest under the differentiated instructional approach, in favour of the male students.

Research Question Two: What are the mean interest ratings of male and female students taught Chemical combination using blended instructional strategy?

Table 3: Mean and Standard Deviation of Interest Ratings of Male and Female Students Taught Chemical Combination Using Blended Instructional Strategy

GenderEG2		PreInterest	PostInterest
Male	Mean	49.52	59.48
	N	27	27
	Std. Deviation	6.375	4.685
Female	Mean	48.48	53.26
	N	23	23
	Std. Deviation	4.220	2.895

Table 3 shows the pre- and post-interest mean ratings and standard deviations for male and female students taught Chemical Combination using the Blended Instructional Strategy (EG2). Male students had pre-

interest mean ratings of 49.52 (SD = 6.38) and post-interest mean ratings of 59.48 (SD = 4.69). Female students had pre-interest mean ratings of 48.48 (SD = 4.22) and post-interest mean ratings of 53.26 (SD = 2.90).

Hypothesis Two: There is no significant difference in the mean interest ratings of male and female students taught Chemical combination using blended strategy.

Table 4: Result of Analysis of Covariance of Male and Female Students' Interest Ratings Taught Chemical Combination Using Blended Instructional Strategy

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	480.870 ^a	2	240.435	14.969	.000	.389
Intercept	1939.020	1	1939.020	120.722	.000	.720
PreInterest	.265	1	.265	.017	.898	.000
GenderEG2	478.345	1	478.345	29.781	.000	.388
Error	754.910	47	16.062			
Total	161527.000	50				
Corrected Total	1235.780	49				

a. R Squared = .389 (Adjusted R Squared = .363)

Table 4 reveals a significant difference in the mean interest ratings between male and female students exposed to a blended instructional strategy. An F-value of $F_{(1, 47)} = 29.781$ 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 implies that male and female students differed significantly in their interest ratings when taught Chemical Combination using the blended instructional strategy. In other words, gender had a significant effect on students' interest in the blended instructional approach, with male students showing greater interest.

Research Question Three: What are the mean achievement scores of male and female students taught Chemical combination using differentiated instructional strategy?

Table 5: Mean and Standard Deviation of Achievement Scores of Male and Female Students Taught Chemical Combination Using Differentiated Instructional Strategy

Gender	EG1	Pretest	Posttest
Male	Mean	8.40	24.73
	N	30	30
	Std. Deviation	2.594	2.083
Female	Mean	9.38	21.50
	N	26	26
	Std. Deviation	1.813	2.970

Table 5 shows the pre-test and post-test mean achievement scores and standard deviations of male and female students taught Chemical Combination using Differentiated Instructional Strategy (EG1). Male students had a pre-test mean score of 8.40 with a standard deviation of 2.59, and a post-test mean of 24.73 with a standard deviation of 2.08. Female students had a pre-test mean of 9.38 and a standard deviation of 1.81, and a post-test mean of 21.50 and a standard deviation of 2.97.

Hypothesis Three: There is no significant difference in the mean achievement scores of male and female students taught Chemical combination using differentiated instructional strategy

Table 6: Result of Analysis of Covariance of Male and Female Students' Achievement Scores Taught Chemical Combination Using Differentiated Instructional Strategy

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	145.737 ^a	2	72.868	11.154	.000	.296
Intercept	1791.841	1	1791.841	274.278	.000	.838
Pretest	.121	1	.121	.019	.892	.000
GenderEG1	137.092	1	137.092	20.985	.000	.284
Error	346.245	53	6.533			
Total	30717.000	56				
Corrected Total	491.982	55				

a. R Squared = .296 (Adjusted R Squared = .270)

Table 6 reveals a significant difference in the mean achievement scores of male and female students exposed to a differentiated instructional strategy. An F-value of $F_{(1, 53)} = 20.985$ 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 implies that male and female students differed significantly in their achievement scores when taught Chemical Combination using differentiated instructional strategy, in favour of the male students.

Research Four: What are the mean achievement scores of male and female students taught Chemical combination using blended instructional strategy?

Table 7: Mean and Standard Deviation of Achievement Scores of Male and Female Students Taught Chemical Combination Using Blended Instructional Strategy

GenderEG2		Pretest	Posttest
Male	Mean	10.33	20.78
	N	27	27
	Std. Deviation	1.961	3.055
Female	Mean	10.61	19.61
	N	23	23
	Std. Deviation	2.190	3.602

Table 7 shows the pre-test and post-test mean achievement scores and standard deviations of male and female students taught Chemical Combination using Blended Instructional Strategy (EG2). Male students had a pre-test mean score of 10.33 with a standard deviation of 1.96, and a post-test mean of 20.78 and standard deviation of 3.06. Female students had a pre-test mean of 10.61 and a standard deviation of 2.19, and a post-test mean of 19.61 and a standard deviation of 3.60.

Hypothesis Four: There is no significant difference in the mean achievement scores of male and female students taught Chemical combination using blended strategy

Table 8: Result of Analysis of Covariance of Male and Female Students' Achievement Scores Taught Chemical Combination Using Blended Instructional Strategy

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	18.637 ^a	2	9.318	.832	.442	.034
Intercept	669.330	1	669.330	59.752	.000	.560
Pretest	1.662	1	1.662	.148	.702	.003
GenderEG2	17.621	1	17.621	1.573	.216	.032
Error	526.483	47	11.202			
Total	21028.000	50				
Corrected Total	545.120	49				

a. R Squared = .034 (Adjusted R Squared = -.007)

Table 8 reveals that there was no significant difference in the mean achievement scores of male and female students exposed to blended instructional strategy. An F-value of $F_{(1, 47)} = 1.573$ was obtained with an associated exact probability value of 0.216. Since the associated probability (0.216) is greater than the 0.05 level of significance, the null hypothesis was not rejected. This result implies that male and female students did not differ significantly in their achievement

scores when taught Chemical Combination using blended instructional strategy.

Discussions

The findings revealed a significant difference in the mean interest ratings of male and female students exposed to differentiated instructional strategy. This indicates that gender significantly influenced students' interest when learning Chemical Combination through differentiated instruction. Specifically, male and female students exhibited differing levels of engagement and enthusiasm under this instructional approach. This finding partially aligns with the studies of Adekunle and Okon (2020) and Alabi and Afolabi (2018), who reported that gender can influence students' motivation and interest in science subjects, depending on the instructional strategies employed. On the contrary, it contrasts with the findings of Oyeniran, Oteyola, Awepetu, and Afolabi (2021), as well as Ilorah and Adeniji (2018), who observed that gender did not significantly affect students' interest when exposed to student-centered instructional methods. The significant gender difference in interest may be attributed to the way differentiated instructional strategies cater to students' individual learning preferences and cognitive styles. Differentiated instruction provides varied

learning activities, tasks, and assessments that may better align with the learning tendencies of one gender over the other, thereby influencing engagement and perceived relevance. For instance, female students may respond more positively to collaborative, structured tasks, while male students may prefer exploratory, hands-on activities within the differentiated framework (Igbo & Solomon, 2021).

The findings revealed a significant difference in the mean interest ratings of male and female students exposed to the blended instructional strategy. This indicates that gender significantly influenced students' interest when learning Chemical Combination through the blended approach. Specifically, male and female students demonstrated differing levels of engagement and enthusiasm under this instructional method. This finding is consistent with the notion that gender can interact with teaching strategies to influence student engagement and motivation, as reported by Adekunle and Okon (2020) and Alabi and Afolabi (2018), who found that blended and technology-enhanced approaches may elicit varying responses from male and female learners. However, it contrasts with the observations of Oyeniran, Oteyola, Awepetu, and Afolabi

(2021), as well as those of Ilorah and Adeniji (2018), who reported no significant gender differences in students' interest in student-centered or blended learning environments.

The significant gender difference in interest under the blended strategy may be explained by the diverse nature of learning activities integrated within the approach. Blended instruction combines online and face-to-face learning, incorporating interactive simulations, multimedia content, and collaborative exercises. Such varied instructional elements may align differently with the preferences, learning styles, and motivational drivers of male and female students. For instance, female students may be more engaged by collaborative discussions and structured multimedia resources, while male students may respond more positively to exploratory simulations and interactive problem-solving exercises.

The findings revealed a significant difference in the mean achievement scores of male and female students exposed to differentiated instructional strategy. This indicates that gender had a significant effect on students' achievement in Chemical Combination when the differentiated instructional approach was employed. Specifically, male and female students demonstrated differing levels of performance, suggesting that the strategy impacted them in distinct ways. This finding is consistent with those of Adeyemi and Olagunju (2022) and Abdullahi and Gana

(2024), who reported that differentiated instructional approaches can yield varied academic outcomes by gender, potentially due to differences in learning styles, engagement, and responsiveness to instructional customization. On the contrary, studies by Oyeniran, Oteyola, Awepetu, and Afolabi (2021) and Ilorah and Adeniji (2018) suggested that gender does not significantly influence achievement under differentiated instruction, highlighting that the effect of gender may be context-dependent.

Differentiated instruction enhances learning by adapting content, process, and learning activities to students' readiness, interests, and abilities. The observed gender differences in achievement could be attributed to variations in how male and female students respond to personalized learning tasks, collaborative activities, or self-paced assignments inherent in the differentiated strategy. Female students, for instance, may show higher achievement due to greater engagement with structured collaborative tasks, attention to detail, or persistence in completing individualized learning activities. In contrast, male students may excel in tasks requiring exploration and experimentation.

The findings revealed no significant difference in the mean achievement scores of male and female students exposed to a blended instructional strategy. This indicates that gender did not have a significant effect on students' achievement in Chemical

Combination when the blended instructional approach was employed. In other words, both male and female students performed comparably under this instructional strategy. This finding aligns with the findings of Oyeniran, Oteyola, Awepetu, and Afolabi (2021), Quahi, Hou, Bliya, Hassounni, and Ibrahim (2021), and Ilorah and Adeniji (2018), who reported that gender does not significantly influence students' achievement when exposed to instructional strategies that integrate multiple teaching methods. The blended instructional strategy combines face-to-face teaching with digital or interactive learning resources, providing a variety of learning experiences that cater to different learning preferences, which may explain the lack of significant gender disparity in achievement. Blended instruction allows students to engage with content both collaboratively and independently, providing opportunities for personalized pacing, repeated practice, and immediate feedback. These features can support both male and female learners equally, mitigating gender-specific learning preferences that may arise. Consequently, the strategy fosters an inclusive learning environment in which all students have an equal chance of achieving success in Chemical Combination.

Recommendations

In view of the findings of this study, the following recommendations are made:

Conclusion

The study concludes that gender plays a significant role in students' interest and achievement in Chemical Combination when exposed to differentiated instructional strategy, as male and female students demonstrated varying levels of engagement and academic performance. Similarly, gender significantly influenced students' interest in a blended instructional strategy, but did not significantly affect their achievement when taught using the same approach. These findings suggest that while differentiated instruction may interact with gender to influence both interest and achievement, blended instructional strategy tends to create a more balanced learning environment that minimizes gender-based differences in achievement. Overall, the results indicate that instructional strategies influence learning outcomes differently across genders, depending on the approach used. Therefore, the effectiveness of teaching strategies in Chemistry should be considered not only in terms of academic outcomes but also in how they interact with learner characteristics such as gender to shape students' interest and performance in Chemical Combination.

1. Chemistry teachers should adopt differentiated instructional strategies in teaching Chemical Combination, ensuring that learning activities,

tasks, and assessments are tailored to students' varying abilities, interests, and learning styles in order to enhance both interest and achievement.

2. Blended instructional strategies should be consistently integrated into chemistry instruction, combining face-to-face teaching with digital tools such as simulations, multimedia resources, and online platforms to promote inclusive learning and improve students' engagement.
3. Teachers should be trained through regular professional development

programs on how to effectively implement both differentiated and blended instructional strategies in science classrooms to maximize their instructional impact.

4. Curriculum planners and educational stakeholders should provide adequate technological infrastructure and instructional resources in schools to support effective implementation of blended learning and other innovative teaching strategies in chemistry education.

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