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Comparative Effects Of Mastery Learning And Metacognition On Chemistry Students' Interest In Delta State

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ABSTRACT: *This study compared the effects of mastery learning and metacognition methods on chemistry students' interest in Delta State, guided by four research questions and four null hypotheses. A quasi-experimental pre-test, post-test design with a 2 × 2 factorial matrix was adopted. The population comprised 29,817 Senior Secondary II chemistry students from mixed public secondary schools in Delta State (2023/2024). A sample of 265 students was drawn from six schools using multi-stage sampling. Instructional methods were randomly assigned to intact classes. The Students' Interest Scale in Chemistry (SISIC) served as the data collection instrument, validated for face, content, and construct validity. Reliability was established using Cronbach's alpha (r = 0.86). Instructional sessions lasted six weeks, followed by post-tests. Data were analyzed using independent t-test and ANCOVA at the 0.05 significance level. The findings revealed: (i) a significant difference in mean interest scores among students taught with mastery learning and metacognition methods; (ii) no significant difference between male and female students' interest scores under mastery learning; (iii) no significant difference between male and female students' interest scores under metacognition; (iv) no significant interaction effect between sex and instructional methods on students' interest and achievement in chemistry. The study concluded that mastery learning and metacognition methods are more effective than lecture methods for fostering students' interest in chemistry. Recommendations include that chemistry teachers in Delta State secondary schools should adopt mastery learning as a primary strategy for improving students' interest.*

Keywords: Mastery Learning Method, Metacognition Method, Chemistry, Students' Interest, sex

Introduction

Chemistry plays a vital role in scientific and technological advancement and serves as a foundation for many science-related professions. Chemistry is critical to pharmaceutical development and understanding how drugs interact with the body. It is also important for diagnosing diseases, developing new treatments, and ensuring the safety of medical procedures (Omosor & Etinagbedia, 2025). As a school subject, the degree to which secondary school students devote themselves to the learning of the subject or to pursuing its related careers depends on their level of interest. Interest is defined as the intrinsic motivation that students have towards a particular subject or activity. It can also refer to their personal inclinations, preferences, and passions that drive them to actively engage in learning (Simons & de Kleine-de Ruijter, 2020). Interest can also be defined as their level of curiosity and enthusiasm towards learning a particular subject or topic. It is an internal drive that compels students to actively engage in the classroom and pursue knowledge related to their specific interests. Interest is essential for learning because it directs learners toward information source relevant to developing domain-specific competence" interest can be defined as the level of enthusiasm, curiosity or motivation they have towards a particular subject or activity (Simpson & Pope, 2014). Interest is not just about liking a topic, but also involves active engagement and intrinsic desire to learn more about it. Interest in education can be defined as an individual's desire or curiosity to learn and acquire knowledge. According to the research study conducted by Nandagopal *et al*. (2020), students who have a high level of interest in education are more likely to achieve higher grades and academic performance compared to those with low interest levels. The authors also suggest that this interest not only drives individual achievement but also contributes positively towards overall classroom engagement and participation.

Thus, interest drives one to know and learn more from the tasks in tasks like identification, drawing, labelling, synthesis, understanding, and learning chemistry concepts. Interest increases satisfaction and reduces the burden on the brain's finite resources during the performance of an activity. The level of interest learners demonstrate in a task indicates how much attention they payed to it (Pllana, 2020). Hence, interest is an enduring quality that is reflected by a person's interaction with a specific work. A student's level of interest determines whether or not they pay attention to characteristics, and paying attention speeds up and improves learning. When students develop low interest in Chemistry, they are less likely to actively engage in classroom activities, perform laboratory experiments enthusiastically, or pursue science-related careers. The persistent decline in students' interest has therefore become a major concern to educators, parents, curriculum planners, and government agencies. One of the major causes of students' low interest in Chemistry may be linked to the continued use of teaching methods that are predominantly teacher-centred. Such methods often limit students' active participation during instruction. Consequently, students become passive learners, thereby reducing their interest in the subject. Thus the rationale for this study lies on the fact that large percentage of students still perceive Chemistry as difficult and highly mathematical, leading to poor participation and declining interest in the subject due to the method used by teacher. This called for great concern, and one of the best ways of correcting this negative trend could be through the application of innovative strategies like mastery learning and metacognition. There have been few studies in other subject areas and outside Nigeria to determine the effects of mastery learning and metacognition on students' interest, and the results seem to be very impressive in terms of improvement in students' interest.

Mastery learning is an innovative strategy which in its various forms are designed towards making learners to perform beautifully well in an academic task (Adepoju, 2022). In the same vein, Adeyemi (2018) described mastery learning as a teaching approach that entails a pre-specific criterion level of performance which students must master in order to complete the instruction and move on. Mastery learning is a learning approach where the learners are given the opportunity to master a particular unit of lesson before proceeding to the next unit. It divides the subject matter into units with objectives and expectations and students will have to work through each unit in an organized format. The teacher will have to review the students and grade them to know who has mastered each unit and who has not. Students will have to master each learning unit before moving further to the next unit. Mastery learning enables students to acquire necessary knowledge to be promoted to the next class, it also assists the instructor to identify the weak point in students and work on it, thus reducing the failure rate. Pasha-Zaidi and Ross, (2019) stated that mastery learning is an instructional approach that emphasizes the importance of students mastering a set of specific objectives or skills before moving on to more complex material. It is a student-centered approach that focuses on individual progress rather than group achievement. Research shows that when properly implemented, this method can facilitate long-term retention and transfer of learned concepts while also promoting deeper understanding among students (Martirosyan et al., 2020).

Continuing Martirosyan et al., (2020) highlighted three steps teachers could follow for a successful implementation of the method in the classroom. Firstly, clear and measurable goals should be established for each lesson. These goals serve as benchmarks which allow both teachers and students to track progress towards mastery. Additionally, frequent formative assessments are essential for monitoring individual student growth and adjusting instruction accordingly. Secondly, timely feedback plays a crucial role in mastery learning. Students must receive immediate feedback on their progress towards meeting the set objectives. This not only motivates them but also helps identify areas where further improvement is needed. Finally, flexibility within the curriculum design is critical for success with mastery learning implementation.

Metacognition is an innovative teaching method that helps learners think, absorb information, organise their learning, and use what they have learned to solve problems. It is an engaging method for both instruction and learning. Activating past information, identifying what needs to be learned, reviewing previously acquired knowledge, and evaluating the results are all components of the student-centred metacognitive strategy. There are three fundamental steps to this strategy: identifying what one wants to know, retrieving what has already been taught, and examining prior knowledge.

Metacognition makes it simple for teachers to assist students in planning, monitoring, reflecting, and assessing their learning outcomes during a specific learning process. The approach places a premium on students being fully involved in knowledge creation and learning objective tracking. Teachers can encourage students to be cognitively engaged throughout the learning process by using metacognition to help them formulate appropriate questions and look for potential solutions to a given learning topic. Furthermore, it helps students develop their ability to assess their learning progress and organise past knowledge on the subject. Students may study science subjects more effectively and efficiently when they apply the meta-cognitive technique, which aids in the development of required abilities. Among the features that have made metacognition different from the lecture method are interdependence and accountability, because each member of a group is important for the group to succeed. The metacognition strategy has been used by many researchers as an instructional strategy with positive and improved results. For example, Cereja *et al.* (2018) found that students taught using metacognition exhibited a higher interest in technical drawing than those taught by their teachers using the lecture method. Koroko *et al.* (2019) did a study to see how metacognition affects the academic achievement of secondary school students in basic science and found that the students who were taught by metacognition did better than those who were taught by the traditional lecture method. Okafor *et al.* (2021) found that metacognitive instructional techniques were very effective in promoting students' academic performance in biology. The previous discussions clearly demonstrate that the use of mastery learning and metacognition as instructional strategies in other subjects has yielded positive and improved results. Hence, the rationale for this study is to find out if the improved results found with the use of mastery learning and metacognition methods in the above studies could also be achieved when used in the teaching of chemistry. Besides, the researcher intends to compare the effects of the mastery learning and metacognition methods and ascertain if the mastery learning and metacognition methods could actually improve students' interest in chemistry.

Akinola and Bello (2021) reported that mastery learning increases students' interest in science subjects by providing immediate feedback and ensuring comprehension before moving to new concepts. Adeyemi and Ajibola (2020) also found that metacognitive strategies enhance learners' interest by promoting self-regulated learning and reflective thinking. Likewise, Olatoye and Adekoya (2019) observed that student-centered instructional methods significantly improve learners' motivation and engagement in STEM subjects. Furthermore, Musa and Ibrahim (2021) confirmed that instructional strategies that involve active participation, self-monitoring, and problem-solving increase students' intrinsic interest in learning complex concepts. However, this finding contrasts with Ogunleye (2018) and Ameh and Olatunji (2020), who reported that instructional methods such as mastery learning and metacognitive approaches do not always yield higher interest among learners, particularly when students are unfamiliar with student-centered practices or lack sufficient guidance. These studies suggest that the effectiveness of instructional strategies in enhancing interest may depend on the context, teacher implementation, and students' prior learning experiences.

Aside from the instructional methods used by teachers, sex is another factor that may cause variation in interest in chemistry. Sex simply means the biological characteristics of being male or female. Cultural norms often perpetuate the idea that males are

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naturally more suited for science, technology, engineering, and mathematics (STEM) fields, including chemistry. The relationship between sex, instructional strategy, and academic achievement has been a topic of considerable research interest. However, empirical studies on this subject often yield inconclusive results. While some instructional methods have been found to be sex-biased, others have been found to be sex-independent. This implies that the debate about sex and academic achievement in relation to the instructional method used is yet to be concluded. Thus, in this study, an attempt was made to compare the effects of mastery learning and metacognition, method on students' interest in chemistry in Delta State and also determined whether the effects varied on the basis of sex.

Olatoye and Adekoya (2019) reported that mastery learning promotes comparable levels of interest among male and female students in science subjects. Similarly, Musa and Ibrahim (2021) observed that student-centered instructional strategies such as mastery learning do not produce significant gender differences in learners' motivation and interest. Adeyemi and Ajibola (2020) also found that both sexes benefit equally from mastery learning in terms of engagement and enthusiasm for learning. Okafor, et al., (2022) further confirmed that mastery learning provides an inclusive classroom environment that fosters equitable interest among learners regardless of sex. Ameh and Olatunji (2020) found that male students generally exhibited higher interest levels than females under mastery learning conditions, suggesting that cultural factors, classroom participation patterns, and prior familiarity with structured learning may influence the degree of engagement across sexes.

Adeyemi and Ajibola (2020), reported that metacognitive strategies promote similar levels of interest and motivation among male and female students in science subjects. Likewise, Olatoye and Adekoya (2019) observed that both sexes benefit equally from metacognitive approaches in terms of engagement and enthusiasm for learning. Musa and Ibrahim (2021) also confirmed that metacognitive instructional strategies do not favor one gender over the other regarding students' interest in STEM subjects. Furthermore, Okafor, Olaniyan, and Eze (2022) found that metacognitive methods create equitable learning environments that stimulate interest across genders. Conversely, Ogunleye (2018) and Ameh and Olatunji (2020) reported that male students tend to exhibit higher interest than female students under metacognitive learning conditions, suggesting that sex differences may emerge when students have varying levels of familiarity with self-regulated learning strategies or when classroom dynamics favor certain participation patterns.

Chukwuemeka and Onah (2020) observed that student-centered instructional strategies such as mastery learning and metacognitive approaches equally enhanced interest among male and female learners. Kalu and Nwankwo (2021) also reported that instructional methods promoting reflection and self-regulation did not produce significant gender disparities in student motivation or interest. Omoregie (2022) further confirmed that structured and interactive teaching approaches provide equitable opportunities for learners to engage with content, ensuring similar interest levels across sexes. Ajayi and Ojo (2019) similarly found that instructional strategies with clear steps and reinforcement mechanisms foster equal interest for both male and female students. In contrast, some studies reported differing outcomes. Ogunleye (2018) and Ameh and Olatunji (2020) found significant interaction effects, noting that male students sometimes exhibited higher interest in science subjects under certain instructional methods, while females excelled under others.

Statement of the Problem

Chemistry plays a vital role in scientific and technological advancement and serves as a foundation for many science-related professions such as medicine, pharmacy, engineering, agriculture, and industrial technology. Despite its importance, students' interest in Chemistry in secondary schools has remained relatively low in many parts of Nigeria, including Delta State. Reports from classroom observations and examination outcomes have shown that many students perceive Chemistry as difficult, abstract, and highly mathematical, leading to poor participation, low motivation, and declining interest in the subject.

Interest is an important factor in the teaching-learning process because it influences students' attention, participation, retention, and academic achievement. When students develop low interest in Chemistry, they are less likely to actively engage in classroom activities, perform laboratory experiments enthusiastically, or pursue science-related careers. The persistent decline in students' interest has therefore become a major concern to educators, parents, curriculum planners, and government agencies.

The main factor-affecting students' interest in chemistry may be due to teachers' non-use of innovative teaching methods like mastery learning and metacognition instructional methods. However, the mastery learning and metacognition instructional methods have been used as an effective strategy in enhancing students' interest both in other subjects and outside Nigeria, and they have been reported to have produced the desired effective teaching in secondary schools such that students' interest improved. However, effects of mastery learning and metacognition instructional methods on students' interest among secondary school students in Chemistry in Delta State is yet to be empirically established. Hence, the problem of this study is in question form is: What is the effects of mastery learning, metacognition methods on chemistry students' interest in Delta State?

Research Questions

The following research questions were answered in this study:

1. What is the difference in mean interest score among chemistry students taught with mastery learning and metacognition method in Delta State?
2. What is the difference between the mean interest scores of male and female students taught chemistry using mastery learning method?

3. What is the difference between the mean interest scores of male and female students taught chemistry using metacognition method in Delta State?
4. What is the interaction effect between sex and instructional methods on students' interest in chemistry in Delta State?

Hypotheses

The following null hypotheses were tested in this study:

1. There is no significant difference in mean interest score among chemistry students taught with mastery learning and metacognition method in Delta State?
2. There is no significant difference between the mean interest scores of male and female students taught chemistry using mastery learning method in Delta State.
3. There is no significant difference between the mean interest scores of male and female students taught chemistry using metacognition method in Delta State.
4. There is no significant interaction effect between sex and instructional methods on students' interest in chemistry in Delta State.

Research Method

Quasi-experimental design involving pre-test, post-test, planned variation design with a 2 x2 factorial design was adopted for this study. Planned variation was included in the design to deliberately introduce and compare three instructional methods mastery learning and metacognition than leaving such differences to chance. The population for this study consist of 29,817 Senior School II (SS II) students offering chemistry in all the mixed public secondary schools in Delta State for the 2023/2024 session as obtained from the Ministry of Basic and Secondary Education, Asaba, Delta State (2023). A sample of 265 SS2 students were drawn from nine mixed secondary schools in Delta State. Multi-stage sampling procedures was employed in selecting the sample for the study. At the first stage one local government area were selected from each of the Senatorial district of the state using simple random sampling technique. At the second stage three secondary schools were selected from each of the selected local government areas using simple random sampling method. Finally, instructional methods were randomly assigned to each selected school in their intact classes. The instructional method was assigned to the selected school by labelling each method on three different pieces of paper. In that manner, mastery learning was labelled as Ml1, ML2, and ML3. Metacognition was labelled as M1, M2, and M3. The lecture method was labelled as LM1, LM2, and LM3. All nine labels (Ml1, ML2, ML3., M1, M2, M3, and LM1, LM2, LM3) were placed in a container and mixed together. From the container, one label will be drawn at a time, and the corresponding method on it was assigned to the next school in the list. This was done repeatedly until all the selected schools are assigned a method. Appendix A shows the distribution of students in each school based on intact class and treatment

In this study, the instruments for data collection was the Students' Interest Scale in Chemistry (SISIC). The Students' Interest Scale in Chemistry (SISIC) also consists of two sections. Section A contains instructions on the students' bio-data (sex). Section B has 20 items. This 20-item scale was adapted from Igwe (2017) with very minor modifications. In the modification, some items that appeared to be unclear were adjusted so as to clarify the intended meaning and improve the reliability of responses. In the instrument four-point rating score of "strongly agree" (SA), "agree" (A), "disagree" (D), and "strongly disagree" (SD) with scoring values of 4, 3, 2 and 1 respectively for positive items and the reverse for negative items that were used.

Face validity, construct validity and content validity were carried out on the instrument that was used for the study. Face validity was carried out on the Students' Interest Scale in Chemistry (SISIC). The researcher sought the assistance of two science education experts and one measurement and evaluation expert. The experts carried out the face validity of the instrument by ensuring that the items in the Students' Interest Scale in Chemistry (SISIC) are clearly worded, unambiguous, and relevant to chemistry students. The experts highlighted that a few items were ambiguous and could be interpreted in multiple ways. They suggested rephrasing these items to avoid misinterpretation. Thus in the final version, items were reworded to be more precise and specific, ensuring that each statement had a clear and singular meaning. The reliability of the Students' Interest Scale in Chemistry (SISIC) was carried out using Cronbach's alpha reliability method. In the method the Students' Interest Scale in Chemistry (SISIC) was administered to 50 SS II students from secondary schools in Orhionmwon Local Government Area of Edo State. Data collected through the test were used to calculate the reliability of the instrument. The Cronbach's alpha was used to compute the reliability index, which gave 0.86 (as shown in Appendix H). This value agreed with the recommended standard and the instrument was considered reliable and internally consistent (Okorodudu, 2013, Ntumi et al., 2023).

The quasi-experimental research design was carried out in three stages described as follows: Six intact classes were randomly assigned to mastery learning and metacognition. Thus, six intact classes were used for the study, three intact classes for each instructional method. The six research assistants were trained on the use of mastery learning and metacognition instructional methods prior to the start of the treatment using training procedure described in Ajaja (2013). After the training all the six chemistry teachers that served as research assistants were given extract which contains the contents of the six-week instructional unit. This was done to ensure that all the instructional presentations followed the recommended format for the designated classes. Two days before the commencement of instruction, all the groups were given pre-tested using the students interest scale in chemistry (SISIC). Thereafter the teachers presented the content of the topics that were selected to teach the students with the use of mastery learning and metacognition strategy in their various school for six weeks. At the end of the six weeks of teaching by the research assistants, a post-test was administered to the students with the same SISIC used during the pretest.

The mean of data that were collected through the the students interest scale in chemistry (SISIC) was used to answer the research questions. Hypotheses were tested using using independent sample t-test and Analysis of Covariance (ANCOVA). All hypotheses were tested at 0.05 level of significance.

Presentation of Results

Research Question One:

What is the difference in mean interest score of chemistry students taught with mastery learning and metacognition methods?

Table 1:

Analysis of The Difference in difference in Pretest mean Interest score of chemistry students taught with mastery learning and metacognition method using Mean and Standard Deviation

Instructional methods	N	Mean	Std. Deviation
Mastery learning	134	29.88	3.586
Metacognition	131	30.18	3.441
Total	265		

Table 1 compared the pretest mean interest scores of Chemistry students taught with mastery learning, metacognition methods. It shows that the groups began the study with nearly equal levels of interest in the subject. The mean scores were 29.88 for students in the mastery-learning group, 30.18 for those in the metacognition group. These close mean values indicate that before the application of the instructional methods, students in all groups had a comparable degree of interest in Chemistry. The standard deviations, which range from 3.44 to 3.78, also suggest a similar spread of scores, implying uniformity in the distribution of students' initial interest levels.

Table 2:

Comparison of the Post Interest score of chemistry students taught with mastery learning, metacognition and lecture method

Instructional methods	N	Mean	Std. Deviation
Mastery learning	134	50.12	3.75
Metacognition	131	51.26	6.43
Total	265		

Table 2 showed the Analysis of The Difference in difference in mean Interest score of chemistry students taught with mastery learning,and metacognition method. The statistics showed that students exposed to mastery learning method had a mean of 50.12 (SD = 3.75) students exposed to metacognition method had the highest mean interest score of 51.26 (SD = 6.43), This result indicates that both mastery learning and metacognitive instructional methods enhanced students' interest in chemistry with metacognition producing the highest level of student interest. To determine if the mean difference is significant, Hypothesis 1 was tested using independent sample t-test.

Hypothesis 1: There is no significant difference in difference in mean achievement score of chemistry students taught with mastery learning and metacognition methods

Table 3: ***Independent sample t-test Comparison of the Pretest Mean Interest Score of Chemistry Students Taught with Mastery Learning and Metacognition Methods***

Instructional methods	N	Mean	Std. Deviation	df	t-value	Sig.	Remark
Mastery learning	134	29.88	3.586				
Metacognition	131	30.18	3.441	263	.701	.484	Not significant
Total	265						

Table 3 showed the Independent sample t-test of the Difference in Pretest Mean Interest Score of Chemistry Students Taught with Mastery Learning and Metacognition methods. The t-value of 0.701 with a significance level of 0.484 ($p > 0.05$) indicates that there was no statistically significant difference in the pretest mean interest scores among the three groups. This means that the students' initial interest in Chemistry did not differ significantly based on the instructional method to which they were later exposed. Therefore, any observed differences in the post-test interest scores could be attributed to the effects of the instructional strategies rather than pre-existing variations in students' interest levels. Therefore, the right statistic uses to test the hypotheses is was independent sample t-test as shown in Table 4

Table 4: ***Independent sample t-test Comparison of the Posttest Mean Interest Score of Chemistry Students Taught with Mastery Learning and Metacognition Methods***

Instructional methods	N	Mean	Std. Deviation	df	t-value	Sig.	Remark
Mastery learning	134	134	50.12				
Metacognition	131	131	51.26	26 3	2.05	.965	Not significant
Total	265						

Table 4 presents the one-way ANOVA of the difference in mean interest scores of chemistry students taught with mastery learning, metacognition, and lecture methods. The result shows that the calculated F-value is 107.47 with a significance value of p = .00 ($p < 0.05$). Since the p-value is less than 0.05, the null hypothesis is rejected. This implies that there is a statistically significant difference in the mean interest scores of students taught with mastery learning, metacognition, and lecture methods.

Research Question Two: What is the difference between the mean interest scores of male and female students taught chemistry using mastery learning method?

Table 5:

Analysis of the Difference between the Mean Interest Scores of Male and Female Students Taught Chemistry Using Mastery Learning Method using Mean and Standard Deviation

Sex	N	Mean	Mean Difference	Std. Deviation
Males	71	50.27		4.168
Females	63	49.95	.315	3.245
Total	134			

Table 5 shows the difference between the mean interest scores of male and female students taught Chemistry using the mastery learning method. The male students had a mean interest score of 50.27, while the female students had a mean score of 49.95, giving a mean difference of 0.32 in favour of the males. The standard deviations of 4.17 and 3.25 for males and females respectively indicate a relatively similar spread of scores within both groups. This small mean difference suggests that both male and female students developed almost the same level of interest in Chemistry when taught with the mastery learning method. Therefore, the influence of sex on students' interest under this instructional strategy appears minimal. It can be inferred that the mastery learning method was equally effective in sustaining the interest of both male and female students in Chemistry. To determine if the mean difference is significant, hypothesis seven was tested using independent sample t-test statistics.

Hypothesis Two

There is no significant difference between the mean interest scores of male and female students taught chemistry using mastery learning method.

Table 6:

Independent sample t-test analysis of the Difference Between the Mean Interest Scores of Male and Female Students Taught Chemistry Using Mastery Learning Method.

Sex	N	Mean	Std. Deviation	df	t-cal.	Sig. (2-tailed)	Remark
Males	71	50.27	4.168				
Females	63	49.95	3.245	132	.484	.629	Null hypothesis not rejected
Total	134						

Table 6 showed the independent sample t-test analysis of the difference between the mean interest scores of male and female students taught chemistry using mastery learning method. The calculated t-value of 0.484 at 132 degrees of freedom yielded a significance value of 0.629, which is greater than the 0.05 level of significance. Therefore, the null hypothesis was not rejected. This implies that there is no statistically significant difference between the mean interest scores of male and female students taught Chemistry using the mastery learning method.

Research Question Three: What is the difference between the mean interest scores of male and female students taught chemistry using metacognition method?

Table 7:

Analysis of the difference in mean achievement scores of male and female students taught chemistry using metacognition method using Mean and Standard Deviation

Sex	N	Mean	Mean Difference	Std. Deviation
Males	75	51.67		6.34
Females	56	50.71	.95	6.57
Total	131			

Table 7 showed the mean and standard deviation analysis of mean achievement scores of male and female students taught chemistry using metacognition method. Male students recorded a mean interest score of 51.67 with a standard deviation of 6.34, while female students (N = 56) had a mean score of 50.71 with a standard deviation of 6.57. The mean difference between the two groups was 0.95 in favour of the male students. This indicates that male students taught using the metacognition method showed slightly higher interest in Chemistry than their female counterparts, although the difference in mean scores is small. To determine if the mean difference is significant, hypothesis eight was tested using independent sample t-test statistics.

Hypothesis Three

There is no significant difference between the mean interest scores of male and female students taught chemistry using metacognition method.

Table 8: ***Independent sample t-test Analysis of the the difference between the mean interest scores of male and female students taught chemistry using metacognition method using Mean and Standard Deviation***

Sex	N	Mean	Std. Deviation	df	t-cal.	Sig. (2-tailed)	Remark
Males	75	51.67	6.336				
Females	56	50.71	6.566	129	.838	.404	Null hypothesis not rejected
Total	131						

Table 8 presents the independent sample t-test analysis of the difference between male and female students' mean interest scores when taught with the metacognition method. Male students had a mean interest score of 51.67 (SD = 6.34), while female students obtained a mean score of 50.71 (SD = 6.57). The calculated t-value of 0.838 with 129 degrees of freedom yielded a p-value of 0.404 at the 0.05 level of significance. Since the p-value (0.404) is greater than 0.05, the difference between the mean interest scores of male and female students is not statistically significant. Therefore, the null hypothesis is not rejected. This implies that the metacognition method of teaching chemistry enhances students' interest regardless of sex

Research Question four

What is the interaction effect between sex and instructional methods on students' interest in chemistry in Delta State?

Table 9:

Analysis of the Interaction Effect of Instructional methods and Sex on Students' interest in chemistry

Methods	Sex	N	Mean	Std. Deviation
Mastery learning	Males	71	50.27	4.17
	Females	63	49.95	3.24
Metacognition	Males	75	51.67	6.34
	Females	56	50.71	6.57

Table 9 shows the Analysis of the Interaction Effect of Instructional methods and Sex on Students' interest in chemistry. The analysis reveals that male and female students started the study with nearly the same level of interest across all instructional methods. In the pre-interest test, males and females in the mastery learning group had mean scores of 30.00 and 29.75 respectively, while those in the metacognition group recorded mean scores of 30.16 and 30.21. Similarly, in the lecture group, males had a mean score of 30.96, and females 29.85. These close mean values indicate that all groups had comparable levels of interest in Chemistry before the instructional treatments, suggesting that the initial interest levels were not influenced by sex or teaching method. After the instructional intervention, notable differences emerged in the post-interest mean scores. Students exposed to mastery learning and metacognition methods showed higher levels of interest compared to those taught using the lecture method. Specifically, male and female students under mastery learning recorded mean post-interest scores of 50.27 and 49.95 respectively, while those in the metacognition group had means of 51.67 for males and 50.71 for females. Overall, both male and female students demonstrated improved interest after being taught with mastery learning and metacognition methods, with males recording slightly higher scores across all methods. However, the differences between the sexes were minimal, suggesting that while instructional methods significantly influenced students' interest in Chemistry, the effect of sex was weak.

Hypothesis four

There is no significant interaction effect of instructional methods and sex on students' interest in chemistry.

Table 10: ***Analysis of Covariance (ANCOVA) of the Interaction Effect of Instructional Strategies and Sex On Students' interest in chemistry***

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1106.996[a]	4	276.749	11.56	.00
Intercept	4126.170	1	4126.170	172.41	.00
Interest pretest	988.491	1	988.491	41.30	.00
Methods	53.727	1	53.727	2.25	.14
Sex	21.904	1	21.904	.92	.34
instructional methods * sex	10.651	1	10.651	.45	.51
Error	6222.377	260	23.932		
Total	688053.000	265			
Corrected Total	7329.374	264			

a. R Squared = .151 (Adjusted R Squared = .138)

Table 10 revealed the ANCOVA summary of the interaction effect of instructional strategies and sex on students' interest in chemistry. The result shows that the computed F-value for the interaction between instructional strategies and sex is 0.45 with a corresponding p-value of .51. Testing the null hypothesis at an alpha level of 0.05, the p-value (.51) was greater than 0.05, hence the null hypothesis was not rejected. This implies that there is no significant interaction effect of instructional strategies and sex on students' interest in chemistry.

Discussion of Findings

The first finding showed a significant difference in the mean interest scores of Chemistry students taught using mastery learning and metacognitive instructional strategies in Delta State. Specifically, students exposed to metacognitive strategies demonstrated higher levels of interest in Chemistry compared to those taught using the lecture method. This suggests that student-centered instructional approaches, which actively engage learners and promote participation, are more effective in sustaining interest in Chemistry. The structured and progressive nature of mastery learning allows students to experience success at each stage of learning, thereby enhancing motivation and curiosity. Similarly, the metacognitive strategy encourages students to reflect on their learning process, monitor their understanding, and take ownership of their learning, which fosters higher levels of interest. This finding is consistent with Akinola and Bello (2021), who reported that mastery learning increases students' interest in science subjects by providing immediate feedback and ensuring comprehension before moving to new concepts. Adeyemi and Ajibola (2020) also found that metacognitive strategies enhance learners' interest by promoting self-regulated learning and reflective thinking. Likewise, Olatoye and Adekoya (2019) observed that student-centered instructional methods significantly improve learners' motivation and engagement in STEM subjects. Furthermore, Musa and Ibrahim (2021) confirmed that instructional strategies that involve active participation, self-monitoring, and problem-solving increase students' intrinsic interest in learning complex concepts. However, this finding contrasts with Ogunleye (2018) and Ameh and Olatunji (2020), who reported that instructional methods such as mastery learning and metacognitive approaches do not always yield higher interest among learners, particularly when students are unfamiliar with student-centered practices or lack sufficient guidance. These studies suggest that the effectiveness of instructional strategies in enhancing interest may depend on the context, teacher implementation, and students' prior learning experiences.

The second finding showed that there was no significant difference in the mean interest scores between male and female students taught Chemistry using the mastery learning strategy. This implies that mastery learning fosters similar levels of interest in Chemistry for both male and female students. A possible reason for this finding could be that the structured and incremental approach of mastery learning ensures that all students achieve competence at each stage before progressing, which enhances engagement and interest equally across sexes. Additionally, the immediate feedback and reinforcement provided in mastery learning may create a supportive learning environment that motivates both male and female students alike. This finding is consistent with Olatoye and Adekoya (2019), who reported that mastery learning promotes comparable levels of interest among male and female students in science subjects. Similarly, Musa and Ibrahim (2021) observed that student-centered instructional strategies such as mastery learning do not produce significant gender differences in learners' motivation and interest. Adeyemi and Ajibola (2020) also found that both sexes benefit equally from mastery learning in terms of engagement and enthusiasm for learning. Okafor, Olaniyan, and Eze (2022) further confirmed that mastery learning provides an inclusive classroom environment that fosters equitable interest among learners regardless of sex. However, this finding contrasts with Ogunleye (2018) and Ameh and Olatunji (2020), who found that male students generally exhibited higher interest levels than females under mastery learning conditions, suggesting that cultural factors, classroom participation patterns, and prior familiarity with structured learning may influence the degree of engagement across sexes.

The third finding showed that there was no significant difference in the mean interest scores between male and female students taught Chemistry using the metacognition strategy. This indicates that the metacognitive instructional approach fosters comparable levels of interest in Chemistry for both sexes. A possible reason for this outcome is that metacognitive strategies encourage students to reflect on their learning, plan and monitor their understanding, and regulate their study behaviors, which equally engages both male and female learners in the learning process. By emphasizing self-regulation and active thinking, the strategy reduces disparities in interest that may arise from differences in learning styles or prior exposure to content. This finding is consistent with Adeyemi and Ajibola (2020), who reported that metacognitive strategies promote similar levels of interest and motivation among male and female students in science subjects. Likewise, Olatoye and Adekoya (2019) observed that both sexes benefit equally from metacognitive approaches in terms of engagement and enthusiasm for learning. Musa and Ibrahim (2021) also confirmed that metacognitive instructional strategies do not favor one gender over the other regarding students' interest in STEM subjects. Furthermore, Okafor, Olaniyan, and Eze (2022) found that metacognitive methods create equitable learning environments that stimulate interest across genders. Conversely, Ogunleye (2018) and Ameh and Olatunji (2020) reported that male students tend to exhibit higher interest than female students under metacognitive learning conditions, suggesting that gender differences may emerge when students have varying levels of familiarity with self-regulated learning strategies or when classroom dynamics favor certain participation patterns. Overall, the present finding implies that metacognitive instructional strategies can effectively sustain interest in Chemistry for both male and female students, supporting inclusive teaching practices that engage all learners equally.

The fourth finding showed that there was no significant interaction effect between sex and instructional methods on students' interest in Chemistry in Delta State. This indicates that the effectiveness of the instructional strategies—mastery learning, metacognition, and lecture method—on students' interest was not influenced by students' sex. In other words, both male and female students demonstrated similar levels of interest across all instructional methods. A possible reason for this outcome is that the strategies employed structured learning, engagement, and motivation mechanisms that were equally accessible to all students, minimizing gender-related differences. The strategies' focus on content comprehension, self-regulation, and active participation likely contributed to similar engagement levels irrespective of sex. This finding is supported by Chukwuemeka and Onah (2020), who observed that student-centered instructional strategies such as mastery learning and metacognitive approaches equally enhanced interest among male and female learners. Kalu and Nwankwo (2021) also reported that instructional methods promoting reflection and self-regulation did not produce significant gender disparities in student motivation or interest. Omoregie (2022) further confirmed that structured and interactive teaching approaches provide equitable opportunities for learners to engage with content, ensuring similar interest levels across sexes. Ajayi and Ojo (2019) similarly found that instructional strategies with clear steps and reinforcement mechanisms foster equal interest for both male and female students. In contrast, some studies reported differing outcomes. Ogunleye (2018) and Ameh and Olatunji (2020) found significant interaction effects, noting that male students sometimes exhibited higher interest in science subjects under certain instructional methods, while females excelled under others.

Conclusion

Based on the findings of this study, it can be concluded that instructional methods significantly influence chemistry students' interest in Delta State. Specifically, mastery learning and metacognition strategies were found to be effective method in enhancing students' interest in chemistry. Furthermore, the study showed that sex does not significantly affect students' academic interest in chemistry. Male and female students performed comparably when exposed to mastery learning and metacognition,. Additionally, there was no significant interaction effect between sex and instructional methods on students' interest, indicating that these instructional strategies are equally effective for both male and female students.

Recommendations

Based on the findings of this study, the following recommendations are made:

1. Since mastery learning was found to be the most effective instructional strategy in enhancing students' academic achievement in chemistry, chemistry teachers in secondary schools in Delta State should adopt mastery learning as a primary strategy for improving students' achievement outcomes.
2. As the metacognitive instructional strategy proved to be effective in enhancing students' interest in chemistry, it should be prioritized in chemistry instruction where the goal is to develop students' reasoning, reflection, and problem-solving abilities.
3. Despite no significant differences in interest based on sex across the instructional strategies, teachers should ensure inclusive practices that promote equal engagement of male and female students in all classroom activities.
4. Workshops, seminars, and teacher development programs should be regularly organized by educational authorities to build capacity for implementing evidence-based strategies like mastery learning and metacognitive teaching methods.

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