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The Relationship Between Reasoning Ability and Retention Ability, Gender and Academic Achievement among Secondary School Chemistry Students

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Abstract

This study investigated the relationship between Reasoning Ability and Retention Ability, Gender and Academic Achievement among Secondary School Chemistry Students in Gwagwalada, Federal Capital Territory, Abuja, Nigeria. Three research questions and corresponding three null hypotheses guided the study. A correlational design was adopted for this study. The target population was all government senior secondary school SS 2 chemistry students in Gwagwalada, Abuja, with a total of 1810 students. A sample size of 200 students was proportionately selected for the study from four secondary schools. The instrument for the study was a researcher designed Chemistry Reasoning Ability Academic Performance Test (CReaAAPT) and Chemistry Retention Ability Academic Performance Test (CRetAAPT) comprising of 20 multiple choice items each to assess the reasoning and retention abilities of the students. A plot study was conducted to assess the construct validity and the reliability of the instruments. Thus, the CReaAAPT had a coefficient of 0.70 while that of CRetAAPT was 0.71, obtained using Kuder-Richardson K-R_{20}.which implied that the instruments were reliable for the study. Inferential statistical analyses of Pearson Product Moment Correlation (PPMC) as well as the independent t- test statistics at $p < 0.05$ significance level was used. The results obtained indicated that: (i) there was significant relationship between reasoning ability and retention ability among the chemistry students in Acids and Bases chemistry concepts. (ii) There was no significant gender difference (male and female) on the Reasoning ability and academic achievement of chemistry students. (iii) There was no significant gender difference (male and female) on retention abilities and academic achievement of chemistry students in acids and bases concepts. The researcher recommends among others that preparatory courses and hands-on activities should be designed to promote the development of scientific reasoning and retentive skills within the context of the discipline.

Keywords: Chemistry, Reasoning ability, Retention ability, Gender, Secondary School

Introduction

Chemistry as a school subject is a branch of physical science concerned with the substances of which matter is composed, the investigation of their properties and reactions, and the use of such reactions to form new substances (Anaso, 2024a). According to Anaso (2024a), Chemistry is one of the key subjects in the science curriculum that forms the foundation for various scientific and technological advancements. It equips students with essential knowledge and skills that are critical for understanding processes at molecular levels. The knowledge of chemistry is applicable

in the fields of medicine, pharmacy, engineering, agriculture and environmental science. Despite the importance and the role of chemistry in human endeavor, students' performance in the subject has consistently been low (Chief Examiner report, WAEC 2021-2023).

Several factors have been identified as contributing to students' poor performance in chemistry; these include poor teaching methods, lack of instructional materials, and low motivation among students (Anaso, 2024b). The issue of large class sizes, inadequate laboratory facilities, and a curriculum that often emphasizes rote memorization over conceptual understanding as observed by (Anaso, 2024c) further complicated the ability of students to succeed in chemistry. Students' cognitive abilities, such as reasoning and retention, which are more critical for academic achievement in chemistry is been, ignored (Ryan & Deci, 2017). Memorization of facts rather than the development of higher-order cognitive skills, which are essential for scientific reasoning and problem-solving is been practiced by many chemistry educators (Anaso, 2024d; Irshad, Azhar, and Kayani, 2023).

However, a crucial aspect that has not been explored is the cognitive dimension, specifically how students' reasoning ability impacts the retention of knowledge. Researchers (Achor and Kampu, 2015; Cracolice and Busby, 2015) have questioned the role of cognitive reasoning ability of students in meaningful learning and retention in science subjects. Cognitive psychology suggests that reasoning and retention is integral to how individuals process information, solve problems, and apply learned concepts (Adewale, 2020).

Reasoning ability refers to the mental capacity to think logically, solve problems, and make decisions, which is critical in understanding complex scientific concepts while retention ability refers to a student's ability to store and recall information over time, which is essential for long-term understanding of chemistry principles. Students with strong reasoning abilities tend to grasp abstract concepts better and apply them effectively in various contexts. Ritchie and O'Keefe (2022) reported that reasoning is broadly categorized into deductive and inductive reasoning, both of which are essential in understanding chemistry. Deductive reasoning according to them involves deriving specific conclusions from general principles, while inductive reasoning refers to the ability to generalize based on specific observations. Zhang and Ding (2019) also found that students who engage in both deductive and inductive reasoning in chemistry tend to retain information more effectively than those who focus on rote memorization.

Cracolice and Busby (2015) reported that when instructors present prepackaged, predigested conceptual systems to students in lecture and textbooks, the instructor have simply taken away the opportunity for students to construct knowledge. With this attitude from the instructors, it means that the classroom and laboratory learning environments do not require students to think, their thinking and reasoning skills cannot develop. Reasoning ability is essential for students to understand, analyze, and apply complex concepts, which are abundant in the chemistry curriculum rather than been presented with prepackaged conceptual systems.

Olatunji and Salihu (2023) maintained that where students are often required to recall formulas, equations, and processes, strong retention skills are developed which are essential for success in chemistry. The relationship between reasoning ability and retention is important in understanding how students learn and apply concepts in chemistry. Owens et al. (2021) reported that strong reasoning skills enhance retention of information, as they facilitate deeper processing and comprehension of the material. Higgins et al. (2020) found that when students are taught to use reasoning to relate chemical reactions to everyday phenomena, they are more likely to remember those reactions because they can contextualize and apply their learning in real-world situations This process of relating new information to what they already know enhances their ability to retrieve and use that information later.

Musa (2022) indicate that the relationship between reasoning and retention mutually reinforce cognitive skills that together determine academic success in chemistry. Retention ability is critical for students to store and retrieve information over time, allowing them to recall key formulas, principles, and processes during exams and in practical applications. Anaso (2024e) pointed out that the teaching instructional strategies employed by educators could significantly affect students' reasoning and retention. Freeman et al. (2014) found that active learning strategies, such as collaborative learning, inquiry-based instruction, and hands-on experiments, have shown to foster deeper understanding and retention. They maintained that when students actively engage in the learning process, they are more likely to develop reasoning skills and retain information effectively.

Several studies have highlighted the positive correlation between strong reasoning skills and better conceptual understanding and retention in science subjects, particularly in chemistry. Chin and Chia (2018) found that students who engaged in argumentation and critical thinking during laboratory activities demonstrated significantly higher retention rates of key chemistry concepts compared to those who participated in traditional lecture-based instruction. This suggests that reasoning tasks not only enhance students' understanding but it also improve their ability to recall and apply the information learned in class, thereby underscoring the link between reasoning and retention. Achor and Duguryil (2015) in their study found that male and female basic science students exposed to content prior to instruction did not differ significantly in their knowledge retention. However, there was a significant interaction effect of method, sex and reasoning ability on students' retention in basic science.

Inquiry-Based Learning (IBL) approaches have also been shown to facilitate the development of reasoning skills while simultaneously improving retention. A study conducted by Hattie (2019) revealed that IBL strategies, which encourage students to pose questions, develop hypotheses, and engage in hands-on experiments, significantly enhanced both reasoning and retention in science education. Students who participated in IBL experiences did not only improved their reasoning abilities but they also exhibited better long-term retention of scientific concepts compared to those who experienced traditional instructional methods. These findings

highlighted the importance of engaging students actively in the learning process to support their cognitive development. For the purpose of this study, the Inquiry based learning (IBL) would be adopted.

This study examines the reasoning ability of students and how it relates to their retention in chemistry. It also seeks to evolve instructional strategies that would enhance the reasoning ability of the students and hence improve their retention ability. Academic performance being an integral part of this study, according to Anaso (2024f) indicates that academic achievement or performance is a complex student behavior and it underlies several abilities for example. memory, previous knowledge or aptitude. It also includes psychological factors such as motivation, interests, temperaments or emotions. Achor and Duguryil (2015) maintained that the learners' level of cognitive style, thinking and reasoning is a major determinant of achievement. They also identified the developmental level of the learner in terms of chronological and cognitive maturity as a major determinant of achievement too. According to Anaso (2024f; 2015), academic achievement determines students' status in the class and gives students an opportunity to develop their reasoning ability and retention ability, so as to improve their grades and prepare them for future academic challenges. Kingsepp (2020) found that students' knowledge decreased during the year without chemistry instruction but the students with chemistry instruction outperformed those without chemistry instruction. There is, therefore, the need to direct efforts at analyzing the relationship between reasoning ability and retention ability of the students and how it affects their academic performance in chemistry.

Gender a variable in this study influences the learning process. Gender, in a narrow sense, is the gender differences, namely male and female. Gender according to Kingsepp (2020); Abakpa, and Anyagh, (2015) is an essential factor in the learning process and it affects various things, for instance they observed that in problem solving in science and mathematics learning, female students are superior to male students. Anaso (2024f) refers gender to be the amount of muscularity and femininity in an individual construct and its roles changes in response to changing values, attitudes, opinions and circumstances. Anaso (2024, 2015) and Omosor, Ajaja, & Kpangban (2024), independently reported that there was no significant difference between the mean achievement scores of male and female students taught chemistry using process-oriented guided inquiry learning.

For the purpose of this study, students were exposed to "Acids and Bases" a basic concept in chemistry. (i) Arrhenius definition of an acid "An acid is a substance which produces hydroxonium ions in water. (ii) Bronsted-Lowry Concept of Acids for instance, It is a proton donor. (iii) Lewis Concept of Acids (iv) Strengths of Acids (v) Physical and chemical properties of Acids (vi) Bases, Arrhenius definition of a base "A base is a substance which reacts with H_3O^+ or H^+ to produce water." (vii) Bronsted-Lowry Concept of Bases (viii) Lewis Concept of Bases (ix) Physical and chemical properties of Bases. Students in groups worked on these tasks listed above using the Inquiry based learning (IBL). The treatment lasted for five weeks.

The aim of this study is to address the knowledge gap on the relationship between reasoning and retention abilities in order to provide valuable insights into how cognitive skills can be used in improving students' academic achievement in chemistry. The results of this study would have significant implications for teaching strategies, curriculum development, and educational policies in Nigeria, particularly in enhancing the quality of chemistry education in secondary schools in Nigeria.

Theoretical Framework

The underlying philosophy for this study is grounded in Constructivist Learning Theory. This theory posits that learners construct their own understanding and knowledge of the world through experiences and reflection. Constructivism emphasizes the active role of the learner in the educational process. The theory highlights the significance of promoting active engagement in the learning process to enhance reasoning abilities and retention among senior secondary school chemistry students. By applying this theory to instructional practices, it enables the teacher to create effective learning environments that support the development of essential skills in chemistry. The framework supports the idea that reasoning and retention are interconnected processes and when students engage in reasoning tasks, they actively construct meaning, which enhances their understanding and retention of the material. The inquiry-based learning activities for instance, prompt students to hypothesize, experiment, and draw conclusions which could facilitate both reasoning skills and retention. Fensham (2017) indicated that constructivist strategy encourages students to make connections between chemical concepts and real-world applications, which reinforce retention.

Statement of the Problem

Chemistry being a key school subject in the science curriculum also forms the foundation for various scientific and technological advancements in the world (Anaso, 2024a). The performance of chemistry students at the secondary school level have been on the decline over the years especially in external examinations like the West African Senior School Certificate Examination (WASSCE) and National Examination Council (NECO) (Anaso, 2024c). The poor performances in chemistry as observed by Anaso (2024b) have reduced the rate at which students' pursue further studies in science-related fields.

Several studies (Anaso, 2024f) have identified lack of sufficient funding, the nature of teaching methods in use, insufficient laboratory facilities, and large class sizes (Anaso and Bichi 2024) as contributory factors to students' poor performance in chemistry. Apart from these factors mentioned, Cracolice and Busby, 2015; Achi and Duguryil, 2015 observed that the cognitive factors, like reasoning ability and retention ability, have not been considered in many analyses of students' performance. In an attempt to solve the problem of poor academic achievement, there is the need for more empirical researches on reasoning ability, retention ability and their

effectiveness in improving academic performance of chemistry students at the secondary school level, hence the need for this study.

This study was undertaken to investigate into the relationship between reasoning ability and retention ability; gender and students' academic performance in chemistry. Few researches seem to have investigated into the relationship between reasoning and retention abilities in chemistry education. It is hoped that the findings of this study would provide a clearer understanding on reasoning ability in order to have higher retention ability and academic achievement in secondary schools in Nigeria.

Objective of the Study

The objective of this study is to:

1. determine the relationship between reasoning ability and retention ability among the chemistry students in Acids and Bases chemistry concepts.
2. determine the reasoning abilities and academic achievement of male and female chemistry students in Acids and Bases chemistry concepts.
3. determine the retention abilities and academic achievement of male and female chemistry students in Acids and Bases chemistry concepts.

Research Questions

The following research questions guided the study:

1. What is the relationship between students' achievement in reasoning ability test and retention ability achievement test in Acids and Bases chemistry concepts?
2. Does reasoning ability and academic achievement have any difference on male and female chemistry students in Acids and Bases chemistry concepts?
3. Retention ability and academic achievement does not have any gender difference (male and female) on chemistry students in Acids and Bases chemistry concepts?

Null Hypotheses

The following null hypotheses guided the study and were tested at 0.05 significant levels.

Ho_1: There is significant relationship between the achievement of students' reasoning ability and retention ability among secondary school chemistry students in Acids and Bases chemistry concepts

Ho_2: There is no significant difference between the mean scores of male and female students in the Reasoning ability test and academic achievement scores of chemistry students in Acids and Bases chemistry concepts.

Ho_3: There is no significant difference between the mean achievement scores of male and female students in retention ability test in Acids and Bases chemistry concepts.

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Methodology

The design used in this study was descriptive survey research of correlation type. This study investigated the relationship between Reasoning Ability and Retention Ability, Gender and Academic Achievement among Secondary School Chemistry Students in Gwagwalada, Federal Capital Territory, Abuja, Nigeria.

The target population for this study was all senior government secondary school SS2 chemistry students with a total of 1810 students from ten government senior secondary schools in the study area. Proportionate random sampling technique was used in selecting a sample of 200 students from four secondary schools in the study location. The sample is made up of 103 female students and 97 male students. The sample was chosen by using Krejcie and Morgan (1970) Table in Anaso (2024d) for determining the sample size from a given population. Proportionate random sampling was used because the subjects of the study comprise male and female students.

A class from each of the schools was randomly drawn using simple hat-drawn method. The materials used for data collection were two instruments developed by the researcher. These were Chemistry Reasoning Ability Academic Performance Test (CReaAAPT) and Chemistry Retention Ability Academic Performance Test (CRetAAPT). CReaAAPT and CRetAAPT were parallel tests of the same level of difficulty and with same chemistry concepts. Each instrument had 20 items to assess the reasoning and retention abilities of the students. The two tests covered the Acids and Bases concepts within the Secondary School Chemistry Curriculum Syllabus.

The validity and reliability of CReaAAPT and CRetAAPT were established by requesting two senior chemistry experts from Federal university of Education Zaria and one educational psychologist from the department. These experts reviewed the items to determine its appropriateness on reasoning ability and retention ability. To establish the reliability of the instruments, a pilot testing on thirty (30) students other than those used in the study was conducted. The reliabilities of the two instruments were computed using Kuder-Richardson K-R_{20}.

Thus, the CReaAAPT had a coefficient of 0.70 while that of CRetAAPT was 0.71, which implied that the instruments were reliable for the study. All the students were taught with the same chemistry topics by the chemistry teachers who were also the research assistants, for a period of five weeks using Inquiry Based Learning. The CReaAAPT was administered first, allowing students to engage with the content. The students were given 40 minutes to complete the test, ensuring that the data collected reflected their reasoning ability under standardized conditions. The CRetAAPT was administered four weeks later to assess the retention ability. The Pearson Product Moment Correlation (PPMC) was used to answer research question one while means and standard deviation were used to answer research questions two and three. Also hypothesis one was tested by using Pearson Product Moment Correlation (PPMC) while hypotheses two and three were tested by using t-test statistic. The level of significance was set at $p < 0.05$.

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Presentation of the Result

The results of the study were presented in terms of research questions and hypotheses respectively as shown in Tables 1-6.

Research Question 1: What is the relationship between students' achievement in reasoning ability test and retention ability achievement test in Acids and Bases chemistry concepts?

Table 1: Summary of Means, variance, Correlation coefficient (r) on the relationship between the Reasoning ability and Retention ability of students in acids and bases chemistry concepts

Variables	N	Mean	STD	Df	Correlation index r	Remark
Reasoning ability score (CReaAAPT)	200	13.62	6.23	198	0.932**	Positive relationship
Retention ability score (CRetAAPT)	200	13.91	4.24			

From Table 1, the Correlation coefficient computed was 0.932. This shows that students' achievement in CReaAAPT and CRetAAPT are positively related. Proportional relationship exists between the Reasoning ability scores and Retention ability scores of chemistry students that is, the higher the Reasoning ability, the higher also is the Retention ability among the students.

Research Question Two: Does reasoning ability and academic achievement have any effect on male and female chemistry students in Acids and Bases chemistry concepts?

Table 2: Summary of Mean and standard deviation on gender effect on the Reasoning ability of chemistry students in Acids and Bases chemistry concepts

	Gender	N	Mean	STD	Mean diff	Remarks
Reasoning ability	Male	97	14.32	6.205	0.89	In favour of Female
	Female	103	15.21	6.132		

Table 2 shows the descriptive Means on gender status of the students and their reasoning ability test. The male and female students reasoning ability mean scores were 14.32 and 15.21 respectively. The result indicated that there was difference within their mean reasoning ability scores. This implies that there was gender difference in reasoning ability. The difference is in favour of the female

Research Question Three: Retention ability and academic achievement does not have any gender effect (male and female) on chemistry students in Acids and Bases chemistry concepts?

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Table 3: Summary of Mean Scores on Retention ability test between male and female chemistry students in Acids and Bases chemistry concepts

	Gender	N	Mean	STD	Mean diff	Remarks
Retention ability	Male	93	13.41	3.30	0.98	In favour of Female
	Female	103	14.39	2.81		

Result from Table 3 shows that both male and female students retention ability score. Their mean scores were 13.41 and 14.39 for males and females respectively. The result indicates difference within their mean retention ability scores. This difference is in favour of the female

Testing of Null Research Hypotheses

Null Hypothesis 1: There is no significant relationship between the achievement of students' reasoning ability and retention ability among secondary school chemistry students in Acids and Bases chemistry concepts.

Table 4: Summary of Means, variance, Correlation Coefficient (r) of the relationship between the Reasoning ability and Retention ability of chemistry students in Acids and Bases

Variables	N	Mean	STD	Df	Correlation index r	Critical r	p-value
Reasoning Score	200	13.62	6.23	198	0.932**	0.220	0.001
Retention Ability	200	13.91	4.24				

P=0.001 < 0.05, correlation index r=0.932 > critical value of 0.220 at df 1 98

Result from Table 4 shows that significant relationship exist between the Reasoning ability and Retention ability scores of chemistry students from the Pearson Product Moment Correlation (PPMC) statistics. Reason being that the correlation index r is 0.932 and critical r is 0.220 at df 198 at P-value of 0.001. That is, the relationship between students' achievement in reasoning ability test and retention ability achievement test is statistically significant. The null hypothesis is hereby rejected

Null Hypothesis 3: There is no significant difference between the mean scores of male and female students in the Reasoning ability test and academic achievement scores of chemistry students in Acids and Bases chemistry concepts.

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Table 5: t-test statistics on gender effect on the Reasoning ability test of chemistry students in Acids and Bases chemistry concepts.

	Gender	n	Mean	STD	Df	t-cal.	t-crit.	p-value	Decision
Reasoning ability	Male	97	14.32	6.205	198	0.819	1.96	0.323	Not sig
	Female	103	14.39	6.132					

P=0.323 >0.05, t-cal, 0.819 < 1.96 r critical at df 198

The result from Table 5 reveals that gender status of the students does not significantly affect their level in reasoning ability test. This is because the calculated p-value of 0.323 is above the 0.05 alpha level of significance and its' computed t value of 0.819 is less than the t critical value 1.96 at df 198. The male and female students reasoning ability scores were 14.32 and 14.39 respectively. There is no significant difference within their mean reasoning ability scores. The null hypothesis is hereby retained.

Null Hypothesis 3: There is no significant difference between the mean achievement scores of male and female students in retention ability test in Acids and Bases chemistry concepts.

Table 6: Summary of t test on gender effect on the Retention ability test of chemistry students in Acids and Bases chemistry concepts

	Gender	N	Mean	STD	Df	t-cal.	t-crit.	p-value	Decision
Retention ability	Male	97	13.41	3.30	198	1.531	1.96	0.165	Not sig
	Female	103	14.39	2.81					

P=0.165 > 0.05, t-cal 1.531 < 1.96 t critical at df 198

The result from Table 6 reveals that gender status of the students does not significantly affect their Retention ability. This is because the calculated p-value of 0.165 is above the 0.05 alpha level of significance and the calculated t- value of 1.531 is less than the critical t-value of 1.96 at df 198. The male and female students Retention ability mean scores were 13.41 and 14.39 respectively. There is no significant difference within their mean Retention ability scores. The null hypothesis is hereby retained.

Findings

1. There is significant relationship between the achievement of students' reasoning ability and retention ability among secondary school chemistry students in Acids and Bases chemistry concepts.
2. There is no significant difference between the mean scores of male and female students in the Reasoning ability test and academic achievement scores of chemistry students in Acids and Bases chemistry concepts.

3. There is no significant difference between the mean achievement scores of male and female students in retention ability test in Acids and Bases chemistry concepts.

Discussion of Findings

Reasoning ability and academic achievement of chemistry students in Acids and Bases chemistry concepts

The null hypothesis focused on relationship between the achievement of students' reasoning ability and retention ability among secondary school chemistry students. The finding showed that there is positive correlation between the students' achievement in the chemistry reasoning ability test and chemistry retention ability test. First, the significant positive correlation between reasoning ability test and retention ability test indicates that students who demonstrate stronger reasoning skills are more likely to retain chemistry concepts. This finding aligns with researches that emphasize the cognitive link between reasoning and memory. Reasoning allows students to actively engage with and process new information, which facilities its transfer into long-term memory, which is critical for effective retention. This finding corroborated with that of Musa (2022) who reported that the relationship between reasoning and retention mutually reinforced cognitive skills that together determine academic success in chemistry. Hattie (2019) also revealed that IBL strategies significantly enhanced both reasoning and retention in science education. They reported that students who participated in IBL experiences did not only improved their reasoning abilities but also exhibited better long-term retention of scientific concepts compared to those who experienced traditional instructional methods.

Male and female students reasoning ability and academic achievement scores of chemistry students in Acids and Bases chemistry concepts.

The Null Hypothesis two focused on the difference between the mean scores of male and female students in the reasoning ability test and academic achievement scores of chemistry students. Irrespective of the difference from the research question in favour of the female, the hypothesis found no significant gender difference between the (male and female) on the reasoning ability and academic achievement of chemistry students, this result indicates that reasoning skills are not influenced by gender, meaning that both male and female students benefited equally from instructional strategies that emphasized reasoning and active learning. This supports the idea that effective teaching strategies should be applicable to all students, regardless of gender. The finding of this study agrees with the results of Anaso (2024f) and Omosor, Ajaja, and Kpangban (2024), who independently reported that there was no significant difference between the mean achievement scores of male and female students taught chemistry using process-oriented guided inquiry learning. The result of this study disagreed with the findings of Kingsepp (2020); Abakpa,

& Anyagh, (2015) who independently reported that female students were superior to male students in problem solving in science and mathematics learning.

Male and female students and retention ability test in Acids and Bases chemistry concepts.

The null hypothesis 3 focused on difference between the mean achievement scores of male and female students in chemistry retention ability test. The difference found from the research question in favour of the female was not enough as the finding from the null hypothesis revealed that gender status of the students did not significantly differ in their retention ability. This highlights the value of instructional approaches that encourage students to identify patterns and form general principles based on observations. The teaching method inquiry-based learning which emphasizes hands-on experiments enhanced retention by allowing students to actively construct knowledge and connect new information to prior understanding. The result of this study is in line with the findings of Achor and Duguryil (2015) who found that male and female basic science students exposed to content prior to instruction did not differ significantly in their knowledge retention.

Conclusion

The study concluded that proportional relationship exists between the Reasoning ability and Retention ability of the chemistry students in government secondary schools under study. It concluded that the higher the reasoning ability, the higher the retention ability among the students. Gender status had no significant effect on students reasoning ability and there was no statistical difference between the mean reasoning ability scores of male and female students. Gender status had no noticeable difference on students' retention ability and there was no statistical difference between the mean retention ability scores of male and female students.

Recommendations

The following recommendations are made on the basis of the findings and conclusions emanating from this study:

1. The problem of underdeveloped scientific reasoning skills should be addressed continuously by chemistry educators; if not students will continue to be lost from the STEM pipeline.
2. Preparatory courses should be designed by curriculum planners to promote the development of scientific reasoning skills within the context of the discipline.
3. Chemistry curriculum developers should review the curriculum by putting methods that has positive consequences in developing the students reasoning and retention abilities.

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