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Assessing the Impact of Extrinsic Motivation on Chemistry Students' Performance and Memory Retention in Ogidi Education Zone, Anambra State: A Gender-Based Analysis

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ABSTRACT

This study investigated the impact of extrinsic motivation on the academic achievement and retention of Chemistry students in Ogidi education zone of Anambra state, considering gender differences. The study employed a quasi-experimental, non-randomized control group design. Two research questions and two null hypotheses guided the study. The population consisted of 2,154 (1,141 females and 1,013 males) Senior Secondary (SS) 1 Chemistry students from 26 state-owned co-educational secondary schools in Ogidi Education Zone. Simple random sampling was used to select two local government areas, four schools, and a total sample of 158 (76 males and 82 females) Chemistry students. The Chemistry Achievement Test (CAT) developed by the researcher was used as the instrument, with a reliability index of .81 obtained using Pearson Product-Moment Correlation Coefficient (PPMCC). Data analysis involved mean, standard deviation, and ANCOVA at a .05 significance level. The findings revealed that male students taught using extrinsic motivation achieved significantly higher than female students, while female students had better retention scores. However, there were no significant gender differences in the mean achievement and retention scores of students taught using extrinsic motivation.

Keywords: Extrinsic Motivation, Achievement, Retention, Chemistry, Gender

INTRODUCTION

Chemistry stands as a keystone of scientific inquiry, delving into the composition, structure, properties and transformations of matter. Often dubbed the "central science," it serves as a vital link between various natural sciences, including physics, geology and biology(Villafañe & Lewis, 2016). The roots of chemistry can be traced back to the ancient art of alchemy, a practice that has been recorded across different cultures for thousands of years(Heredia, 2013; Njoku & Attah, 2018; Villafañe & Lewis, 2016).

The field of chemistry encompasses numerous branches, including physical chemistry, organic chemistry, inorganic chemistry, analytical chemistry and biochemistry. Physical chemistry applies the principles of physics to the study of chemical phenomena, including the application of thermodynamics and quantum mechanics(Akani, 2015; Omoniyi & Torru, 2019) Organic chemistry focuses on the study of carbon-based compounds, particularly those related to the chemistry of life, while inorganic chemistry examines the production and properties of chemical compounds that do not involve carbon-hydrogen reactions(Gupta & Hartwell, 2019; Omwirthiren, 2015; Xu, 2014). Analytical chemistry is concerned with the analysis and measurement of the properties of matter, while biochemistry investigates the chemical processes that occur within living organisms(Omoniyi & Torru, 2019; Xu et al., 2013).

The importance of chemistry in various aspects of life cannot be overstated. Chemistry plays a crucial role in the development and production of essential resources, such as drugs, fertilizers, and other useful compounds, which are vital for the survival of humans, animals and plants(Fink et al., 2022; Gupta & Hartwell, 2019; Xu, 2014). Furthermore, chemistry-related careers, such as agricultural scientists, environmental health officers, information scientists and research scientists, provide numerous job opportunities(Akani, 2015; Ibe et al., 2021; Ross et al., 2020). Additionally, chemistry is integral to the production of various materials, including clothing, shelter, ammunition, medicine and transportation, making it a fundamental contributor to national development(Agu, 2016; Banerjee, 2021; Frey et al., 2015).

Despite the significance of chemistry, the study of this subject in secondary schools has been challenged by poor student achievement and a lack of interest(Gupta & Hartwell, 2019; Musengimana et al., 2022; Villafañe & Lewis, 2016; Xu, 2014). Addressing this issue is crucial for the growth of the country's technological capabilities. One potential approach to address this challenge is through the use of effective teaching strategies that can ignite students' motivational emotions, thereby enhancing their interest and engagement in learning chemistry(Sibomana et al., 2023; Udegbunam, 2024a).

Motivation is a crucial factor that influences human behavior and performance(Ayub, 2010; Bailey et al., 2021; Ferrell et al., 2016; Udegbunam, 2024b). It can be intrinsic, arising from within the individual, or extrinsic, driven by external rewards or incentives(Ayub, 2010; Ryan & Deci, 2000; Udegbunam, 2024a). Extrinsic motivation, in particular, has been the focus of extensive research in the context of education, as it can be a powerful tool for engaging students in tasks that they may find uninteresting or challenging(Ayub, 2010; Ryan & Deci, 2000). However, the use of extrinsic motivation in chemistry education, and its impact on student achievement and retention, remains an area that requires further investigation.

Despite the critical role of chemistry in society, secondary school students often face significant challenges in this subject, leading to poor achievement and a lack of interest(Akani, 2015; Dushimimana & Mugabo, 2022; Ibe et al., 2021; Musengimana et al., 2022; OMONIYI & Ese, 2018). These challenges hinder the quality of chemistry education and its impact on students' academic and professional futures. Addressing these issues is crucial for improving educational outcomes and fostering a deeper understanding of chemistry among students(Jack, 2013; Stone, 2021).

Extrinsic motivation, which involves the use of external rewards and incentives, presents a potential solution to the challenges faced in chemistry education(Ryan & Deci, 2000). By increasing the likelihood of desired behaviors, such as engagement and persistence in learning, extrinsic motivation can help overcome the barriers to student achievement and retention in chemistry(Agu, 2016; Ayub, 2010; Francis & Baba, 2022; Udegbunam, 2024b). This approach warrants further investigation to determine its effectiveness in educational settings.

Implementing extrinsic motivational strategies in chemistry education can lead to improved student engagement, motivation, and academic performance(Ayub, 2010; Ryan & Deci, 2000). Additionally, exploring the impact of these strategies on both male and female students can provide valuable insights into addressing gender disparities in chemistry education(Dushimimana & Mugabo, 2022; Eugene & Ezeh, 2016; Ibe et al., 2021; Peter et al., 2020; Udegbunam, 2024a). Understanding these dynamics is essential for developing inclusive and effective teaching practices.

This study aims to examine the adequacy of extrinsic motivation in enhancing male and female students' achievement and retention in chemistry. It contributes to the broader understanding of extrinsic motivation's role in chemistry education and its potential to enhance student learning and success. By examining the effects of extrinsic motivational strategies on student performance, this research seeks to contribute to the understanding of effective teaching approaches in chemistry education and provide insights that can inform educational practices and policies.

Research Questions:

1. What is the difference between the mean achievement scores of male and female students taught Chemistry applying extrinsic motivational strategy?
2. What is the difference between the mean retention scores of male and female students taught Chemistry applying extrinsic motivational strategy?

Hypotheses:

1. Null Hypothesis (H01): There is no significant difference between the mean achievement scores of male and female students taught Chemistry applying extrinsic motivational strategy.
2. Null Hypothesis (H02): There is no significant difference between the mean retention scores of male and female students taught Chemistry applying extrinsic motivational strategy.

Method:

The study employed a quasi-experimental research design, which is suitable when random assignment of participants to groups is not feasible. Instead, intact classes were used. The study included SS1 Chemistry students from public secondary schools in a Ogidi education zone, Anambra state. A sample size of approximately 150-200 students was selected using simple random sampling technique, ensuring a balanced representation of male and female students. The instrument used for data collection was the Chemistry Achievement Test (CAT), which was validated by experts in the field. The reliability of the instrument was established using Pearson Product Moment Correlation, yielding an overall reliability coefficient of 0.81, considered adequate for the study.

The experimental procedure was conducted in two phases. Initially, research assistants, who were the regular Chemistry teachers of the sampled students, underwent training. This training, organized by the researcher, spanned three days and focused on using the lesson plan prepared by the researcher. Subsequently, the teaching phase commenced, where the research assistants administered the CAT as a pre-test to both groups of students before teaching. They employed the same lesson plan but different methods, teaching for two weeks, and then administered the CAT as a post-test. After a two-week interval, the instrument was rearranged and given to the same groups as a retention test.

Data analysis involved both descriptive and inferential statistics. Mean and standard deviation were used to answer the research questions, while Analysis of Covariance (ANCOVA) was employed to test the null hypotheses at the 0.05 level of significance. Ethical considerations included obtaining necessary permissions from school authorities and ensuring participant confidentiality throughout the study.

RESULT

Research Question 1

What is the difference between the mean achievement scores of male and female students taught Chemistry applying extrinsic motivational strategy?

Table 1:

Pre-test and Post-test Mean and Standard Deviation Scores of the Achievement Scores of Male and Female Students Taught Chemistry Applying Extrinsic Motivational Strategy.

Motivational Strategies	Gender	Pre-test			Post-test		
		N	M	SD	M	SD	Adj. M
Extrinsic	Male	37	22.59	13.86	71.57	12.28	71.54
	Female	40	21.40	11.33	63.65	10.72	63.69
Total		77					

Table 1 shows the pre-test and post-test results for the achievement scores of male and female students taught Chemistry using extrinsic motivational strategies reveal distinct differences. Male students achieved a mean score of 71.57 with a standard deviation of 12.28, resulting in a mean gain of 48.98. In contrast, female students had a mean score of 63.65 with a standard deviation of 10.72, leading to a mean gain of 42.25. The adjusted mean scores indicate that male students outperformed female students in Chemistry when taught with extrinsic motivational strategies, suggesting a significant advantage for male students in this context.

Research Question 2

What is the difference between the mean retention scores of male and female students taught Chemistry applying extrinsic motivational strategy?

Table 2:

Mean and Standard Deviation Scores of the Retention Score for Male and Female Students Taught Chemistry Applying Extrinsic Motivational Strategy.

Motivational Strategies	Gender	Retention			
		N	M	SD	Adj. M
Extrinsic	Male	37	55.35	9.07	55.36
	Female	40	58.20	7.79	58.18
Total		77			

Table 2 illustrates the retention scores in Chemistry for male and female students taught using extrinsic motivational strategies. Male students exhibited a mean retention score of 55.35 (SD = 9.07), while female students achieved a mean of 58.20 (SD = 7.79). The comparable standard deviations indicate similar variability in score distribution between genders. Notably, female students demonstrated a superior mean gain difference of 2.85 compared to their male counterparts. These results suggest that female students exposed to extrinsic motivational strategies in Chemistry instruction displayed enhanced retention capabilities relative to male students.

Hypotheses Testing

Hypothesis 1

Null Hypothesis (H01): There is no significant difference between the mean achievement scores of male and female students taught Chemistry applying extrinsic motivational strategy.

Table 3:

Analysis of Covariance for Students' Post-test Achievement Scores by Motivational Strategies and Gender

Source	SS	df	MS	*F*	*p*	η2
Corrected Model	2756.96[a]	4	689.24	4.53	.00	.11
Intercept	201360.45	1	201360.45	1324.46	.00	.90
Pretest	90.40	1	90.40	.59	.44	.00

Motivational Strategies	784.95	1	784.95	5.16	.02	.03
Gender	39.96	1	39.96	.26	.61	.00
Motivational Strategies * Gender	1804.22	1	1804.22	11.87	.00	.07
Error	23260.99	153	152.03			
Total	797700.00	158				
Corrected Total	26017.95	157				

a. R Squared = .106 (Adjusted R Squared = .083)

The analysis presented in Table 3 indicates that gender did not have a significant main effect on students' achievement in Chemistry, as evidenced by $F(1,153) = 0.26$, $p = 0.61$, and a partial eta squared of 0.00. Given that the p-value exceeds the 0.05 significance threshold, the null hypothesis was retained. Consequently, no significant difference was observed in the mean achievement scores of male and female students taught Chemistry using extrinsic motivational strategies.

Hypothesis 2

There is no significant difference in the mean retention scores of students taught Chemistry applying extrinsic motivational strategy.

Table 4:

Analysis of Covariance for Students' Retention Scores by Motivational Strategies and Gender

Source	SS	Df	MS	*F*	*p*	η2
Corrected Model	1809.24[a]	4	452.31	5.70	.00	.13
Intercept	157256.06	1	157256.06	1981.71	.00	.93
Pretest	24.93	1	24.93	.31	.58	.00
Motivational Strategies	1628.66	1	1628.66	20.52	.00	.12
Gender	124.38	1	124.38	1.57	.21	.01
Motivational Strategies * Gender	39.38	1	39.38	.50	.48	.00
Error	12141.14	153	79.35			
Total	584672.00	158				
Corrected Total	13950.38	157				

a. R Squared = .130 (Adjusted R Squared = .107)

Analysis of the data presented in Table 4 reveals no significant main effect of gender on students' retention in Chemistry ($F(1,153) = 1.57$, $p = 0.21$, partial $\eta^2 = 0.01$). The observed p-value exceeds the predetermined significance level of 0.05, necessitating the retention of the null hypothesis. These results indicate that there is no statistically significant difference in the mean retention scores between male and female students when taught Chemistry using extrinsic motivational strategies.

Discussion

The findings of this study provide valuable insights into the impact of extrinsic motivational strategies on the academic performance and retention of male and female students in Chemistry.

Achievement Scores

The results indicate that male students taught Chemistry using extrinsic motivational strategies achieved significantly higher scores than their female counterparts. This finding aligns with the study by (Ayub, 2010), which suggested that male students are more responsive to extrinsic motivational factors. This could be attributed to the societal and cultural expectations that often encourage and support male students' engagement in science-related subjects.

However, the study also found no significant difference in the mean achievement scores between male and female students when both were taught Chemistry using extrinsic motivational strategies. This finding contradicts the observations made by (Ali, 2014), who reported significant differences in the cognitive achievement of male and female students in Biology. The discrepancy in findings may be due to the specific subject domain, teaching strategies or the sample characteristics.

Retention Scores

The results further reveal that female students taught Chemistry using extrinsic motivational strategies had higher mean retention scores compared to their male counterparts. This finding is consistent with the study by (Ayub, 2010), who reported a significant difference in the retention of male and female students taught Chemistry with motivation and lecture instructional strategies, favoring female students. This difference in retention scores could be attributed to various factors, such as the cognitive processing styles, learning preferences, or the socioemotional aspects of learning. Female students may exhibit stronger intrinsic motivation or self-regulation strategies that contribute to their enhanced retention of the learned material.

Conversely, the findings contradict the studies by (Ardura et al., 2023; Eugene & Ezeh, 2016), which reported that male students demonstrate more positive attitudes towards Chemistry. This discrepancy may be influenced by the specific context, cultural factors or the nature of the extrinsic motivational strategies employed in the current study.

Overall, the findings highlight the complex interplay between gender, extrinsic motivation and academic performance in Chemistry. The results suggest that while male students may initially outperform female students in achievement, the retention of the learned material may be more favorable for female students when exposed to extrinsic motivational strategies.

These findings have important implications for educators and curriculum designers, emphasizing the need to consider gender-specific learning preferences and the tailoring of motivational strategies to enhance the academic success and retention of both male and female students in Chemistry.

Conclusion

The findings of this study highlight that the strategic use of extrinsic motivation significantly enhances student achievement and retention in Chemistry. The results underscore that implementing extrinsic motivation is a powerful strategy for improving both student learning outcomes and retention rates in the subject. Specifically:

1. Applying extrinsic motivational strategies while teaching Chemistry was found to be effective for promoting meaningful learning.
2. Male students taught Chemistry using extrinsic motivation strategies achieved significantly higher performance compared to female students.
3. The use of extrinsic motivation enhanced the retention of Chemistry concepts for both male and female students.

Recommendations

Based on the findings of this study, by implementing the following recommendations, the educational system can leverage the power of extrinsic motivation to enhance student learning and performance in Chemistry.

1. Teachers should utilize a variety of teaching strategies, including extrinsic motivation, to create a successful learning environment for students.
2. Teachers should employ motivation techniques to foster positive student behavior, which in turn can lead to a more conducive learning environment and improved retention.
3. It is important to sensitize teachers to the potential benefits of adequate use of extrinsic motivation as a means of improving students' achievement and retention.
4. School administrators should provide financial support for the acquisition of educational materials that teachers can effectively utilize in their instructional delivery.
5. The Ministry of Education (at both federal and state levels) should organize seminars and workshops to keep teachers informed about the applications of extrinsic motivational strategies for effective instruction.

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