STUDENTS' PERFORMANCE IN BASIC SCIENCE AS A PREDICTOR OF THEIR PERFORMANCE IN CHEMISTRY IN SENIOR SECONDARY CERTIFICATE EXAMINATION

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Abstract

This study investigated whether students' performance in Basic Science in the Basic Education Certificate Examination (BECE) predicts their performance in Chemistry in the Senior Secondary Certificate Examination (SSCE) within the Vandeikya Education Zone. The study was guided by three research questions and three null hypotheses. An ex-post facto research design was employed. The population consisted of 4,875 students, while the sample comprised 488 Basic Science students from the 2021 cohort and 488 Chemistry students from the 2024 cohort, all with complete and verifiable examination records. An inventory developed by the researchers was used to systematically extract and organize performance data, serving as the primary instrument for data collection. Regression analysis was conducted to answer the research questions and test the hypotheses at the 0.05 level of significance. Results revealed that performance in Basic Science significantly predicted students' performance in Chemistry at the SSCE level, accounting for 48.0% of the variance ($F(1, 486) = 145.415$, $p < 0.05$). For male students, Basic Science performance predicted 38.0% of the variance in Chemistry scores ($F(1, 242) = 40.894$, $p < 0.05$), while for female students, the predictive power was even stronger at 55.9% ($F(1, 242) = 109.973$, $p < 0.05$). Based on these findings, it was recommended that teachers and schools should prioritize strengthening Basic Science instruction at the junior secondary level to provide a solid foundation for students' future success in Chemistry and other science subjects. Educators and policymakers should also utilize BECE Basic Science results to identify students at risk of underperformance and implement targeted academic support and interventions prior to their progression to senior secondary school.

Key Words: Basic Science, Chemistry, BECE, SSCE, academic performance and gender

Introduction

Science education plays a crucial role in transforming the social and economic lives of citizens in any nation. It involves teaching and learning a body of knowledge, acquiring skills, and fostering positive attitudes through engagement in scientific processes. The Nigerian National Policy on Education

emphasizes active science learning at all education levels (FRN, 2014). Scholars note that meaningful national development in the 21st century is unattainable without science and technology (Agu & Isei, 2018; Samba & Kpiranyam, 2021). Consequently, science education empowers learners with real-world problem-solving skills and prepares them for careers in Science, Technology, Engineering, and Mathematics (STEM) fields. Enamarie (2016) highlights that Nigeria's aspiration to be among the world's most scientifically and technologically advanced nations depends on establishing a firm foundation in science education from childhood, nurturing curiosity, interest, and positive attitudes toward Basic Science.

In Nigeria, Basic Science is a core subject within the nine-year Basic Education curriculum (FRN, 2014). It focuses on fundamental scientific principles and processes, aiming to build inquiry skills, critical thinking, and environmental awareness. The curriculum covers key topics including living and non-living things, human health, energy, and environmental science. This foundational knowledge equips students for advanced scientific study and fosters scientific literacy essential for informed citizenship and national development. Basic Science integrates disciplines such as Mathematics, Physics, Chemistry, and Biology, forming the basis for applied sciences and technological progress.

Chemistry deals with matter's properties, synthesis, uses, and reactions, is critical in this progression. Olufunke (2020) describes Chemistry as the study of matter, its interactions, and energy changes. Its branches include Biochemistry, Geochemistry, Organic, Physical, Industrial, Inorganic, Medical Chemistry among others (Akpochimore, 2018). The goal of Chemistry education is to develop individuals capable of identifying problems, making inferences, and

applying scientific knowledge to solve practical challenges (Obialor & Chukwuagu, 2020). Effective Chemistry teaching encourages hands-on and minds-on learning, enhancing understanding, interest, and positive attitudes, which contribute to higher student performance.

Despite Chemistry's importance, student performance in this subject at the senior secondary level has been inconsistent. WAEC results from 2018 to 2023 reveal that fewer than 50% of students achieved credit passes in some years. Researchers attribute poor performance to factors such as inadequate subject knowledge, incomplete syllabus coverage, unfamiliar exam formats, weak reading habits, and psychological challenges (Anyaegbu, Aghuauhe & Nnamani, 2017; Gambari, Obielodan & Kawu, 2017; Olubumi & Ese, 2018). Furthermore, poor secondary school science performance has been linked to insufficient mastery of Basic Science concepts at the junior secondary level (Enemarie, Ogbeba & Ajayi, 2018; Ezugbwu, Mbonu-Adigwe, Ibenegbu & Okoye, 2022). Students who fail to grasp foundational science concepts during Basic Education often struggle with advanced topics in Chemistry. Key concepts such as atomic structure, chemical bonding, and the periodic table require a solid foundation, and lack thereof hampers male and female students' ability to cope with the subject's abstract and technical demands (Nahum, Mamlok-Naaman, Hofstein & Taber, 2010).

Gender inequality continues to influence science education. Okigbo (2020) defines gender as socially constructed roles and expectations differing from biological sex. Gender stereotypes can shape students' interests and performance in science, often discouraging girls due to cultural beliefs about gender-appropriate subjects. Addressing these stereotypes is essential to foster an inclusive environment that

encourages all students to engage fully in science learning. Research findings on gender's influence on academic performance are mixed: some studies report a male advantage when scaffolding instructional strategies are used (Okigbo & Anyanwumelu, 2021), others find no gender differences (Gambari in Onuh & Okigbo, 2020; Ajio, Ode & Kpiraynam, 2023), while some identify gender as a significant factor with females outperforming males (Nwoye, Okeke & Nwosu, 2020).

There has been inconsistency in the literature regarding the relationship between students' performance in Basic Science at BECE and their performance in Chemistry at SSCE, particularly when considering gender. For instance, Enemarie, Ogbeba, and Ajayi (2018) found a significant predictive relationship between male students' Basic Science performance and their success in Biology at the SSCE level. However, studies by Nweke, Ogbaga, and Olodu (2021), Istifanus, Hamza, and Aliyu (2022), and Kigbu, Dauda, and Inusa (2022) reported that male students' knowledge of Basic Science at BECE was not a significant predictor of their Chemistry performance at SSCE (WAEC).This study sought to find out if male and female students performance in Basic Science in Basic Education Certification Examination (BECE) could predict their performance in Chemistry in the Senior Secondary Certificate Examination (SSCE).

Purpose of the Study

The study aimed to find out if students' performance in Basic Science in Basic Education Certification Examination could predict their performance in Chemistry in the Senior Secondary Certificate Examination. The specifically objectives were to:

1. find out if students' performance in Basic Science in BECE could predict their performance in Chemistry in SSCE.
2. determine if male students' performance in Basic Science in BECE could predict their performance in Chemistry in SSCE.
3. ascertain if female student performance in Basic Science in BECE could predict their performance in Chemistry in SSCE.

Research Questions

To achieve the aims of this study, the following research questions were answered:

1. What is the predictive relationship between students' performance in Basic Science in BECE and their performance in Chemistry in SSCE?
2. What is the predictive relationship between male students' performance in Basic Science in BECE and their performance in Chemistry in SSCE?
3. How will female student performance in Basic Science in BECE predict their performance in Chemistry in SSCE?

Hypotheses

The following null hypotheses were tested at 0.05 level of significance.

1. Students' performance in Basic Science in BECE does not significantly predict their performance in Chemistry in SSCE.
2. Male students' performance in Basic Science in BECE does not significantly predict their performance in Chemistry in SSCE.
3. Female student performance in Basic Science in BECE does not

significantly predict their performance in Chemistry in SSCE.

Research Method

This study employed ex-post facto research design to investigate the relationship between students' Basic Science performance at the Basic Education Certificate Examination (BECE) level and their subsequent performance in Chemistry at the Senior Secondary Certificate Examination (SSCE) level. The study was conducted in the Vandeikya Education Zone, Benue State, Nigeria, an area comprising 84 secondary schools offering Basic Science and Chemistry as core science subjects. The zone encompasses four Local Government Areas: Vandeikya, Konshisha, Kwande, and Ushongo. The selection of this locale was motivated by documented inconsistencies in student performance in Chemistry at the SSCE level, and the absence of empirical studies addressing this phenomenon within the region. The population comprised 4,875 students enrolled in schools offering the relevant science subjects. A total sample of 488 students was drawn using multi-stage sampling procedure integrating purposive, simple random, and systematic random sampling techniques. Specifically, the sample included 488 Basic Science students from the 2021 cohort and 488 senior secondary students from the 2024 cohort, with complete and verifiable examination records. Data were obtained from official examination results. Basic Science scores from the 2021 BECE conducted by the Benue State Examination Board and Chemistry scores from the 2024 SSCE conducted by the WAEC were sourced from the schools by the researchers. An inventory was developed by the researchers to systematically extract and organize students' performance data, which served as the primary data collection instrument. Given the retrospective nature of the inquiry, the ex-post facto design was deemed appropriate as it allowed for the analysis of pre-existing variables without manipulation. The study focused on the dependent variable students' performance in Chemistry at the SSCE level while examining the predictive influence of the independent variable - Basic Science performance at the BECE level. Statistical analysis was conducted using regression statistic to test the hypothesized relationships and answer the research questions at a 0.05 level of significance. Regression analysis was selected for its suitability in determining the strength and direction of the association between the independent and dependent variables within the study context.

Results

The results are presented in tables according to the research questions and hypotheses.

Research Question One

What is the predictive relationship between students' performance in Basic Science in BECE and their performance in Chemistry in SSCE?

Table 1: Regression Analysis between Students' Performance in Basic Science in BECE and their Performance in Chemistry in SSCE

Model	n	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	488	.480[a]	.230	.229	3.722

Table 1 shows the regression analysis of the predictive relationship between students' performance in Basic Science in BECE and their performance in Chemistry in SSCE. The correlation coefficient (R) value of 0.480 (48.0%) indicates a positive regression weight. The coefficient of determination (R^2) is 0.230. This implies that only 23.0% of the variation in students' performance in Basic Science in BECE explain the variability in their performance in Chemistry in SSCE.

Research Question Two

What is the predictive relationship between male students' performance in Basic Science in BECE and their performance in Chemistry in SSCE?

Table 2: Regression Analysis between Male Students' Performance in Basic Science in BECE and their Performance in Chemistry in SSCE

Model	n	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	244	.380[a]	.145	.141	3.795

Table 2 shows the regression analysis of the predictive relationship between male students' performance in Basic Science in BECE and their performance in Chemistry in SSCE. The correlation coefficient (R) value of 0.380 (38.0%) indicates a positive regression weight. The coefficient of determination (R^2) is 0.145. This implies that only 14.5% of the variation in male students' performance in Basic Science in BECE explain the variability in their performance in Chemistry in SSCE.

Research Question Three

How will female student performance in Basic Science in BECE predict their performance in Chemistry in SSCE?

Table 3: Regression Analysis between Female Students' Performance in Basic Science in BECE and their Performance in Chemistry in SSCE

Model	n	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	244	.559[a]	.312	.310	3.644

Table 3 shows the regression analysis of the predictive relationship between female students' performance in Basic Science in BECE and their performance in Chemistry in SSCE. The correlation coefficient (R) value of 0.559 (55.9%) indicates a positive

regression weight. The coefficient of determination (R^2) is 0.312. This implies that only 31.2% of the variation in female students' performance in Basic Science in BECE explain the variability in their performance in Chemistry in SSCE.

Hypothesis One: Students' performance in Basic Science in BECE does not significantly predict their performance in Chemistry in SSCE.

Table 4: ANOVA of Multiple Regression Relationship between Students' Performance in Basic Science in BECE and Performance in Chemistry in SSCE

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	2014.856	1	2014.856	145.415	.000[b]
	Residual	6733.964	486	13.856		
	Total	8748.820	487			

Table 4 reveals students' performance in Basic Science in BECE and their performance in Chemistry in SSCE. From Table 4 $F(1, 486) = 145.415$, $p = 0.000<0.05$. Thus, the null hypothesis that Students' performance in Basic Science in BECE does not significantly predict their performance in Chemistry in SSCE was rejected. This means that the students' performance in Basic Science in BECE significantly predict their performance in Chemistry in SSCE.

Hypothesis Two

Male students' performance in Basic Science in BECE does not significantly predict their performance in Chemistry in SSCE.

Table 5: ANOVA of Multiple Regression Relationship between Male Students' Performance in Basic Science in BECE and Performance in Chemistry in SSCE

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	588.936	1	588.936	40.894	.000[b]
	Residual	3485.142	242	14.401		
	Total	4074.078	243			

Table 5 reveals male students' performance in Basic Science in BECE and their performance in Chemistry in SSCE. From Table 5 $F(1, 242) = 40.894$, $p = 0.000<0.05$. Thus, the null hypothesis that male students' performance in Basic Science in BECE does not significantly predict their performance in Chemistry in SSCE was rejected. This means that the male students' performance in Basic Science in BECE significantly predict their performance in Chemistry in SSCE.

Hypothesis Three: Female student performance in Basic Science in BECE does

not significantly predict their performance in Chemistry in SSCE.

Table 6: ANOVA of Multiple Regression Relationship between Female Students' Performance in Basic Science in BECE and Performance in Chemistry in SSCE

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	1460.591	1	1460.591	109.973	.000[b]
	Residual	3214.077	242	13.281		
	Total	4674.668	243			

Table 6 reveals female students' performance in Basic Science in BECE and their performance in Chemistry in SSCE. From Table 6 $F(1, 242) = 109.973$, $p = 0.000 < 0.05$. Thus, the null hypothesis that female students' performance in Basic Science in BECE does not significantly predict their performance in Chemistry in SSCE was rejected. This means that the female students' performance in Basic Science in BECE significantly predict their performance in Chemistry in SSCE.

Discussion of Findings
This study investigated whether students' performance in Basic Science at the BECE could predict their performance in Chemistry at the SSCE. The results revealed that students' performance in Basic Science accounts for 48.0% of the variance in their Chemistry performance, indicating a strong predictive relationship. This means that students' performance in Basic Science can be effectively used to forecast their success in Chemistry. The finding is both intuitive and supported by educational theory: early mastery of foundational science concepts contributes to better outcomes in specialized science subjects later on. This underscores the critical role of a strong early science education in shaping students' future academic performance in Chemistry. This finding is consistent with previous research by Enemarie, Ogbeba, and Ajayi (2018), who found a significant relationship between students' performance in Basic Science and Biology. Similarly, it aligns with Ezugbwu et al. (2022), who reported that variations in students' performance in Biology were significantly predicted by their Basic Science performance. Additionally, the result concurs with Istifanus, Hamza, and Aliyu (2022), who established that knowledge of Basic Science at BECE significantly predicts students' performance in Chemistry at SSCE (WAEC). The implication of this finding is that Basic Science performance can serve as an early indicator of students' future success in Chemistry. Educators and policymakers can use BECE results to identify students who may need additional support before progressing to senior secondary science courses, allowing for timely interventions that improve learning outcomes in Chemistry.

Findings revealed that male students' performance in Basic Science at the BECE

significantly predicts their performance in Chemistry at the SSCE. This result aligns with the study by Enemarie, Ogbeba, and Ajayi (2018), who found a significant predictive relationship between male students' Basic Science performance and their success in Biology at the SSCE level. However, this finding contradicts earlier studies by Istifanus, Hamza, and Aliyu (2022) and Kigbu, Dauda, and Inusa (2022), which reported that male students' knowledge of Basic Science at BECE was not a significant predictor of their Chemistry performance at SSCE (WAEC). It also disagrees with Nweke, Ogbaga, and Olodu (2021), who found that performance in Basic Science at JSSCE did not significantly predict male students' performance in Chemistry. Given these conflicting results, it suggests that the relationship between early performance in Basic Science and later success in Chemistry for male students may be context-dependent, potentially influenced by factors such as teaching quality, curriculum variations, or individual student characteristics. Therefore, further research is needed to identify the specific conditions and contexts under which Basic Science performance can reliably predict Chemistry performance among male students.

Findings revealed that female students' performance in Basic Science at the BECE significantly predicts their performance in Chemistry at the SSCE. This result aligns with the findings of Enemarie, Ogbeba, and Ajayi (2018), who reported a significant predictive relationship between female students' performance in Basic Science and their success in Biology at the SSCE level. Similarly, it corroborates the studies of Istifanus, Hamza, and Aliyu (2022) and Kigbu, Dauda, and Inusa (2022), which found that female students' knowledge of Basic Science at BECE significantly predicts their performance in Chemistry at SSCE. Additionally, it supports the findings of

Nweke, Ogbaga, and Olodu (2021), who demonstrated that performance in Basic Science at JSSCE is a significant predictor of female students' success in Chemistry. The consistent relationship between female students' early performance in Basic Science and their later success in Chemistry highlights the critical importance of a strong foundational science education for female learners. Therefore, it is essential that teachers and policymakers provide adequate support and encouragement to female students in Basic Science during the junior secondary level to enhance their academic trajectory in science subjects.

Conclusion
This study found that students' performance in Basic Science at BECE significantly predicts their performance in Chemistry at SSCE, explaining 48% of the variation in Chemistry scores. The predictive relationship holds for both male and female students. The results highlight the importance of strong foundational science education and suggest that BECE results can be used to identify students needing early support in Chemistry at the senior secondary level. This early intervention can enhance learning outcomes and better prepare students for success in senior secondary science subjects, particularly Chemistry.

Recommendation
Based on the findings, the following recommendation are made:

1. Teachers and schools should prioritize improving the quality of Basic Science teaching at the junior secondary level to build a solid foundation for success in science subjects, particularly Chemistry.
2. Educators and policymakers should use BECE Basic Science results to identify male and female students, especially those at risk of poor performance and provide targeted academic support and

interventions before they progress to senior secondary school.

3. School authorities and curriculum implementers should develop and implement strategies that specifically encourage and support male and female students in Basic Science to sustain their performance in science particularly, Chemistry.

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