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PROF. PATRICK C. IGBOJINWAEKWU

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EDITORIAL

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Prof. Patrick C. Igbojinwaekwu
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COGNITIVE ABILITY AS CORRELATE OF SECONDARY SCHOOL STUDENTS' ACHIEVEMENT IN GENETICS

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Abstract

This study investigated the relationship between cognitive ability and students' achievement in Genetics among senior secondary school students in Anambra State, Nigeria. Genetics, an important concept in Biology with applications in medicine, agriculture, and biotechnology, continues to pose challenges to learners as reflected in persistent poor performance in external examinations. Cognitive ability, representing students' intellectual capacity to reason, analyze, and solve problems, is recognized as a crucial factor in learning outcomes. A correlational research design was adopted for the study. The population comprised 13,596 SS3 Biology students enrolled in 267 public secondary schools across six education zones in the 2023/2024 academic session. A sample of 300 students was selected through multistage sampling techniques. Data were collected using the Students' Cognitive Ability Scale (SCAS), validated by experts in Science Education, with a reliability coefficient of 0.76 established using Cronbach's alpha. Students' achievement in Genetics was measured using their continuous assessment and examination scores. Data were analyzed using linear regression to answer the research questions, while ANOVA of regression was used to test the hypotheses at 0.05 level of significance. Findings revealed a significant positive relationship between cognitive ability and achievement in Genetics, with gender showing no significant moderating effect. The study concluded that cognitive ability plays a critical role in students' achievement in Genetics and recommended that teachers adopt differentiated instructional strategies that cater to varying levels of cognitive ability among learners.

Keywords: Cognitive Ability, Academic Achievement, Genetics

Introduction

Biology is the scientific study of life. It is the application of reasoning and logic to understand how living organisms function and interact with their natural environment (Ejezube et al, 2025). As a core science subject, Biology not only explains life processes but also equips learners with practical skills relevant for medicine, agriculture, industry, and socio-economic development. At the secondary school level, Biology is taught to enable students to acquire adequate laboratory and field skills, develop meaningful and relevant knowledge in Biology, apply scientific knowledge to everyday life, and cultivate interest in science-related careers. These objectives underscore the importance of Biology in fostering scientific literacy and preparing students for future academic and professional pursuits.

Among its concepts, Genetics is particularly significant as it explains heredity and variation, clarifying how traits are transferred from one generation to another (Obiakor, 2020). Advances in genetics is further amplified by increase transformation in areas of agriculture, improved food security, and addressed social concerns such as paternity, disease control and population management (Abdulahi, 2022).

Despite its importance, students continue to perform poorly in Genetics, as highlighted by WAEC Chief Examiners' Reports. Common weaknesses include inability to demonstrate conceptual understanding, apply scientific logic, and engage in critical thinking. These deficiencies contribute substantially to the overall achievement gap in Biology, particularly in relation to gender.

Gender refers to the socially constructed roles, behaviors, and attributes that a society considers appropriate for males and females (Akinsola, 2018). In educational contexts, gender has been identified as an important variable influencing students' cognitive development and academic achievement. Research findings on gender differences in cognitive ability and achievement have been mixed. While some studies suggest that male students tend to outperform females in science-related tasks requiring spatial and analytical skills, others report no significant difference or even better performance among female students when provided with supportive learning environments (Okeke, 2019; Ezeudu, 2021). These variations indicate that gender-related differences in achievement may be influenced more by environmental, instructional, and socio-cultural factors than by innate ability.

Efforts to improve achievement in Genetics have often emphasized teaching methods, but learner-related variables remain critical. Among these, cognitive ability the intellectual capacity to reason, solve problems, and process information stands out as a strong determinant of achievement. Students with high cognitive ability are often better able to analyze complex concepts, retain knowledge, and apply it in problem-solving situations, while those with lower ability may struggle even with effective teaching.

Although studies have examined factors such as gender and study habit, relatively few have focused specifically on how cognitive ability correlates with students' achievement in Genetics. Addressing this gap is essential for improving instructional practices and providing tailored support for learners. From the foregoing, this study

investigates the relationship between cognitive ability and students' achievement in Genetics at the senior secondary level in Anambra State, Nigeria.

Statement of the Problem

Despite the recognized importance of Genetics in Biology and its relevance to national development, students at the senior secondary school level continue to exhibit poor achievement in this area, as evidenced by consistent reports from examination bodies such as WAEC. This persistent underperformance is characterized by weak conceptual understanding, poor application of scientific reasoning, and limited problem-solving ability. While previous efforts to address this issue have largely focused on improving teaching methods, less attention has been given to learner-related factors such as cognitive ability, which may significantly influence students' understanding and achievement in Genetics. Furthermore, inconsistencies in findings regarding the role of gender in academic achievement create uncertainty about how male and female students differ in their learning outcomes. Consequently, there is a need to investigate how cognitive ability relates to students' achievement in Genetics, and whether this relationship varies across gender. This gap in knowledge necessitates the present study.

Purpose of the Study

The purpose of this study is to determine the relationship between cognitive ability and students' achievement in Genetics in Anambra State. Specifically, the study seeks to:

1. Ascertain the relationship between cognitive ability and students' achievement in Genetics.
2. Determine extent of relationship between cognitive ability and achievement in Genetics with respect to gender.

Research Questions

1. What is the relationship between cognitive ability and students' achievement in Genetics?
2. What is the relationship between cognitive ability and gender on students' achievement in Genetics?

Hypotheses

The following null hypotheses guided the study and were tested at 0.05 level of significance;

1. There is no significant relationship between cognitive ability and students' achievement in Genetics.
2. There is no significant relationship between cognitive ability and gender on students' achievement in Genetics.

Methods

The research design adopted for this study was the correlational design, deemed appropriate for determining the magnitude and direction of relationships between variables and making predictions (Cohen, Manion, & Morrison, 2018). The study was

carried out in Anambra State, which has 21 Local Government Areas distributed across six education zones (Aguata, Awka, Nnewi, Onitsha, Ogidi, and Otuocha). Public secondary schools in the state share common features, such as the use of uniform Biology textbooks, similar teacher–student ratios, and reliance on conventional teaching methods, with students recording relatively average performance in SSCE Biology.

The population comprised 13,596 SS3 Biology students (6,313 males and 7,283 females) enrolled in 267 public secondary schools during the 2023/2024 academic session. A sample of 300 students was selected using multistage procedures. Two education zones were stratified and selected, after which one Local Government Area was drawn from each. Three schools per LGA that met criteria such as functional Biology laboratories and qualified teachers were purposively sampled, giving six schools in total. Intact classes were used, yielding the 300 students studied.

The instrument used for data collection was the Students' Cognitive Ability Scale (SCAS), a 20-item 4-point Likert-type scale developed by the researcher, validated by experts in Measurement, Evaluation, and Biology Education. Trial testing with 30 SS3 students produced a reliability coefficient of 0.76 using Cronbach's alpha, confirming internal consistency. Students' achievement in Genetics was measured using their continuous assessment and examination scores in the subject. Data collection was carried out by the researcher with the help of trained Biology teachers. SCAS was administered to students, while their achievement scores were obtained from school records. Data were analyzed using linear regression to answer the research questions, with coefficients of correlation (R) and determination (R^2)

reported. Hypotheses were tested using regression ANOVA at the 0.05 significance level.

Results

Research Question One: What is the relationship between cognitive ability and Biology students' academic achievement in genetics?

Table 1: Regression presentation of relationship between cognitive ability and biology students' academic achievement in genetics.

Variable	R	R^2	Adjusted R^2	Estimated Error	Decision
Achievement	0.803	0.752	0.712	6.05301	High Correlation

(Hint: R values less than 0.30 is of low correlation, 0.31-0.80 is mild correlation while values above 0.81 are high correlation).

Data in Table one revealed that the correlation coefficient (R) of between cognitive ability and biology students' academic achievement in genetics is 0.803 with a coefficient of determination of 0.712. since the value of R is greater than 0.80 as in the decision rule, it therefore implies that cognitive ability has a high correlation on biology students' achievement in genetics. The R^2 revealed that 75.20% of students' variance in achievement in genetics were informed by variance in their cognitive abilities. Also, adjustment in R^2 indicated 71.20% of total variance in achievement was a s a result of biology students' cognitive abilities. Hence, cognitive ability has a high positive correlation of biology students' achievement in genetics.

Research Questions 2: What is the relationship between cognitive ability and gender on achievement in genetics?

Table 2: Regression presentation of relationship between cognitive ability and gender biology students' academic achievement in genetics.

Variable	R	R^2	Adjusted R^2	Estimated Error	Decision
Male	**0.775**	**0.657**	**0.660**	**5.5910**	**Mild Correlation**
Female	**0.801**	**0.774**	**0.772**	**5.77630**	**High Correlation**

(Hint: R values less than 0.30 is of low correlation, 0.31-0.80 is mild correlation while values above 0.81 are high correlation).

Table two revealed that the correlation coefficient (R) between cognitive ability and gender on biology students' academic achievement in genetics. It revealed that the correlation coefficient between male students' cognitive ability and their achievement is 0.775 with a coefficient of determination of 0.657. Since the male students' value of R is less than 0.80 as in the decision rule, it therefore implies that male students' cognitive ability has a minimal correlation on their achievement in genetics. The R^2 revealed that 65.70% of male students' variance in achievement in genetics were informed by variance in their cognitive abilities. Also, adjustment in R^2 indicated 66.00% of total variance in achievement was a s a result of male biology students' cognitive ability.

Coming to the female students, the table revealed a correlation coefficient 0.801 with a coefficient of determination of 0.774 between their cognitive ability and achievement in genetics. Since the R value is greater than 0.80 as in the decision rule, it therefore implies that female students' cognitive ability has a higher correlation on

their achievement in genetics. The R^2 revealed that 77.40% of female students' variance in achievement in genetics were informed by variance in their cognitive abilities. Also, adjustment in R^2 indicated 77.20% of total variance in achievement was a s a result of female students' cognitive ability. Hence, female students' cognitive ability has a positive correlation on achievement in genetics than the males.

Testing Hypotheses

Hypothesis 1: There is no significant relationship between cognitive ability and Biology students' achievement in genetics.

Table 3: Linear regression of cognitive ability as correlate of biology students' academic achievement in genetics.

Model	Sum of Square.	df	Mean Square.	F-Value	P-Value
Regression:	**2565.661**	**1**	**2565.661**	**14.231**	**.003**
Residual:	**55020.36**	**328**	**8200.620**		
Total:	**57586.021**	**329**			

(Hint: P-values greater than .05 is accepted while P-value less than .05 is rejected).

Table 3 revealed an F-ratio of 14.231 and a P-value of .003. In accordance with the decision rule or benchmark, since the P-value of .003 is less than .05 level of significance, the null hypothesis of "no significant relationship between cognitive ability and biology students' achievement in genetics" is rejected. Hence, an alternative hypothesis of "there is significant relationship between cognitive ability

and biology students' achievement in genetics" is formulated and accepted. This therefore indicated that cognitive ability has high correlation on the achievement of biology students in genetics.

Hypothesis 2: There is no significant relationship between cognitive ability and gender on Biology students' achievement in genetics.

Table 4: Linear regression of cognitive ability and gender on biology students' academic achievement in genetics.

Model	Sum of Square.	df	Mean Square.	F-Value	P-Value
Male	Regression:	3015.141	1	3015.141	.261
.001					
	Residual:	24021.160	220	121.016	
	Total:	27036.301	221		
Female	Regression:	3025.031	1	2565.661	.252
.000					
	Residual:	23025.46	131	9100.520	
	Total:	26050.491	132		

(Hint: P-values greater than .05 is accepted while P-value less than .05 is rejected).

Table 4 revealed an F-ratio of .261 and a P-value of .001 for male students. It also indicated an F-ratio of .252 and a P-value of .000 for female students In accordance

with the decision rule or benchmark and since the P-value of .001 and .000 are less than .05 level of significance respectively, the null hypothesis of "no significant relationship between cognitive ability and gender on biology students' achievement in genetics" is rejected. Hence, an alternative hypothesis of "there is significant relationship between cognitive ability and gender biology students' achievement in genetics" is formulated and accepted. This therefore indicated that cognitive ability has positive correlation on the achievement of biology students in genetics.

Discussion

Findings of the study revealed that cognitive ability significantly correlates with students' achievement in Genetics. Students with higher cognitive ability performed better in Genetics than their counterparts with lower ability. This suggests that cognitive ability plays a central role in shaping how learners engage with and master complex Biology concepts. Genetics, being abstract and logic-driven, requires students to analyze, synthesize, and apply information to solve problems. These intellectual demands align directly with the traits captured by cognitive ability, such as reasoning, problem-solving, and critical thinking. The positive association observed in this study therefore reinforces the argument that cognitive ability is a critical predictor of performance in science learning.

This finding aligns with the observations of previous researchers such as Nworgu (2015) and Umeh (2021), who noted that students with higher levels of cognitive ability tend to excel in science subjects because they are better able to understand abstract concepts, organize information, and apply it in examinations. It also supports

the assertion of Pintrich and Schink (2018) that cognitive factors significantly shape achievement outcomes across different areas of science. The result of this study thus provides empirical evidence that achievement gaps in Genetics may be partly explained by variations in students' cognitive ability rather than instructional strategies or teacher-related factors alone.

The study also revealed that while male students recorded slightly higher achievement scores than their female counterparts at similar levels of cognitive ability, the difference was not statistically significant. This indicates that gender does not moderate the relationship between cognitive ability and achievement in Genetics**.** In other words, once cognitive ability is accounted for, male and female students benefit equally in terms of achievement outcomes. This finding is noteworthy because it suggests that effective teaching strategies and school support should focus more on strengthening cognitive abilities of learners rather than on gender-based considerations.

This result corroborates studies by Danjuma (2015), Muhammad (2017), and Hayatu and Okoronka (2016), who reported that gender did not significantly predict achievement in science and mathematics when key cognitive and instructional factors were considered. However, it contrasts with findings by Gupta, Pasrija, and Kavita (2015) as well as Oluwatelure (2015), who found gender-related differences in science achievement. The disparity could be due to variations in cultural contexts, student populations, or subject domains investigated. Nonetheless, the present study affirms that cognitive ability is a more decisive factor in predicting achievement in Genetics than gender.

The implication of these findings is that Biology educators and policymakers must prioritize interventions that enhance cognitive skills such as logical reasoning, problem-solving exercises, and inquiry-oriented tasks among students. By doing so, schools can help bridge performance gaps in Genetics. Furthermore, since gender does not significantly moderate the relationship, these interventions can be implemented uniformly across male and female students with the assurance of equitable benefits.

Conclusion

The study concluded that cognitive ability is a significant determinant of students' achievement in Genetics at the senior secondary school level in Anambra State. Students with higher cognitive ability demonstrated superior performance, underscoring the importance of intellectual capacity in mastering abstract Biology concepts. Furthermore, gender was found not to significantly influence the relationship between cognitive ability and achievement, indicating that both male and female students benefit equally when cognitive demands are adequately supported.

By highlighting the pivotal role of cognitive ability, this study emphasizes the need for Biology teachers to adopt instructional strategies that strengthen reasoning, critical thinking, and problem-solving skills among learners. Such practices will not only improve students' achievement in Genetics but also prepare them with the intellectual competencies required for success in higher education, scientific careers, and national development.

Recommendations

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

1. Biology teachers should incorporate classroom activities that deliberately strengthen students' cognitive abilities such as logical reasoning tasks, problem-solving exercises, and inquiry-driven learning. These will enhance students' capacity to understand and apply abstract concepts in Genetics.
2. Curriculum planners and textbook developers should integrate content and exercises that require higher-order thinking skills into the Biology curriculum, ensuring that students engage in tasks that stimulate reasoning beyond rote memorization.
3. Educational policymakers and ministries of education should organize regular professional development workshops for teachers, equipping them with strategies for fostering cognitive skill development among learners.
4. School administrators should provide enabling environments such as functional laboratories, resource-rich libraries, and ICT facilities to encourage exploration and cognitive engagement during Biology lessons.
5. Co-researchers and professional bodies should use the findings as a basis for designing broader interventions that emphasize the role of cognitive ability in achieving equity and excellence in science education.

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