Cognitive ability and study habits as predictors of secondary school students' academic achievement in biology in Awka South

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ABSTRAK

Penelitian ini bertujuan menganalisis kemampuan kognitif dan kebiasaan belajar sebagai prediktor prestasi akademik Biologi siswa sekolah menengah di Awka South, Negara Bagian Anambra, Nigeria. Penelitian menggunakan desain korelasional prediktif dengan sampel 100 siswa kelas Senior Secondary II dari 10 sekolah menengah negeri yang dipilih melalui teknik pengambilan sampel bertahap. Data dikumpulkan menggunakan tes kemampuan kognitif, angket kebiasaan belajar, dan nilai ujian kumulatif Biologi tahun akademik 2024/2025. Analisis menggunakan regresi linear sederhana dan berganda pada taraf signifikansi 0,05. Kemampuan kognitif memprediksi prestasi Biologi secara positif dan signifikan ($r = 0,203$; $R^2 = 0,041$; $p = 0,043$). Kebiasaan belajar menunjukkan hubungan prediktif positif dan signifikan ($r = 0,620$; $R^2 = 0,384$; $p < 0,001$). Kedua variabel secara bersama-sama menjelaskan 43,0% variasi prestasi Biologi ($R = 0,656$; $R^2 = 0,430$; $F(2, 97) = 36,590$; $p < 0,001$). Kebiasaan belajar menjelaskan proporsi variasi prestasi yang lebih besar dalam model sederhana. Temuan ini mendukung perhatian terhadap pengembangan kemampuan kognitif dan kebiasaan belajar yang terstruktur dalam pembelajaran Biologi.
Kata Kunci: kemampuan kognitif; kebiasaan belajar; prestasi akademik; Biologi

ABSTRACT

This study examined cognitive ability and study habits as predictors of secondary school students' academic achievement in Biology in Awka South, Anambra State, Nigeria. A predictive correlational design was adopted. The sample comprised 100 Senior Secondary II students from 10 public secondary schools, selected through multistage sampling. Data were collected using a Cognitive Ability Test, a Study Habit Questionnaire, and cumulative Biology examination results for the 2024/2025 academic session. Simple and multiple linear regression analyses were conducted at the 0.05 significance level. Cognitive ability positively and significantly predicted Biology achievement ($r = 0.203$, $R^2 = 0.041$, $p = 0.043$). Study habits also showed a positive and significant predictive relationship ($r = 0.620$, $R^2 = 0.384$, $p < 0.001$). Together, the predictors explained 43.0% of the variation in Biology achievement ($R = 0.656$, $R^2 = 0.430$, $F(2, 97) = 36.590$, $p < 0.001$). Study habits accounted for a larger proportion of achievement variance in the separate regression models. The findings supported attention to cognitive development and structured study practices in Biology education.
Keywords: cognitive ability; study habits; academic achievement; Biology

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1. INTRODUCTION

Academic achievement reflects the knowledge and skills that students demonstrate through school assessments and examinations. It provides a basis for evaluating learning outcomes and identifying areas that require instructional attention. In Biology, achievement involves understanding living organisms, interpreting biological processes, and applying scientific knowledge. These capacities are relevant to further learning in health, agriculture, and environmental science. Research on achievement in Nigerian secondary schools has

examined both students' psychological characteristics and the learning conditions in which academic tasks are completed (Enebechi et al., 2023; Okolocha & Okeke, 2018).

Cognitive ability and study habits represent two distinct aspects of students' engagement with academic tasks. Cognitive ability refers to the mental capacities involved in reasoning, comprehension, memory, and problem-solving. Study habits concern the recurring practices through which students organise time, work with learning materials, sustain concentration, and prepare for examinations. Examining these variables together provides a basis for understanding how students' cognitive resources and learning practices are associated with achievement in Biology.

The relevance of cognitive ability to school achievement has been demonstrated across educational settings. Deary et al. (2007) examined the association between intelligence and subsequent educational achievement among English schoolchildren and reported a positive relationship across academic subjects. Roth et al. (2015), in a meta-analysis of intelligence and school grades, also established a positive association. Rindermann and Neubauer (2004) investigated relationships among processing speed, intelligence, creativity, and school performance. These studies support the consideration of cognitive ability when examining differences in students' academic achievement.

Within science education, cognitive processes are relevant to understanding relationships among concepts, interpreting evidence, and solving subject-specific problems. Raslan (2023) examined critical thinking skills among high school students studying Advanced Placement Chemistry, highlighting reasoning and the evaluation of arguments in science learning. Shi and Qu (2021) investigated cognitive ability and self-control in relation to high school students' comprehensive academic performance. In Nigeria, Akinwumi et al. (2023) reported a positive relationship between mental ability and Biology performance among secondary school students in Ondo State. The latter finding provides subject-specific support for examining cognitive ability in relation to Biology achievement in Awka South.

Study habits encompass time management, reading, note-taking, concentration, revision, and examination preparation. These practices determine how students organise their engagement with learning tasks. Ebele and Olofu (2017) investigated study habits and Biology performance among secondary school students in the Federal Capital Territory, Abuja, and reported a significant relationship. Their findings support attention to the ways students study Biology in addition to the content presented during classroom instruction.

Other studies have considered study practices within broader learning processes. Iqbal et al. (2022) examined emotional intelligence and study habits in blended learning environments, with cognitive engagement as a mediating variable. Suarni et al. (2024) investigated independent study habits alongside text-based learning in relation to fiction-writing skills among primary school pupils. These studies situate study habits within students' active participation in learning, while differing in educational level, subject, and outcome from the present investigation.

Learning practices also develop within social and instructional environments. Darling-Hammond et al. (2020) discussed the integration of cognitive, social, and emotional processes in educational practice. Nair and Fahimirad (2019) examined life skills in relation to undergraduates' personal and social competencies, while Akudo (2020) investigated classroom arrangement and student discipline in secondary schools in Anambra State. These perspectives provide background for considering the organisation of learning, while the present study focuses specifically on cognitive ability and study habits as predictors of Biology achievement.

In secondary school Biology, students are expected to understand increasingly complex concepts and undertake independent study. Cognitive ability may support the interpretation and retention of biological information, whereas study habits concern the regular practices through which students engage with that information. Evaluating the variables separately identifies their respective predictive relationships with achievement. Evaluating them jointly establishes the proportion of achievement variance explained when both are included in the same model.

This study therefore examined cognitive ability and study habits as predictors of secondary school students' academic achievement in Biology in Awka South Local Government Area, Anambra State. Specifically, it determined the predictive relationship between cognitive ability and Biology achievement, the predictive relationship between study habits and Biology achievement, and the joint prediction of achievement by both variables. The study tested three null hypotheses at the 0.05 significance level: cognitive ability does not significantly predict Biology achievement; study habits do not significantly predict Biology achievement; and cognitive ability and study habits do not jointly significantly predict Biology achievement.

2. RESEARCH METHOD

A. Research Design and Participants

The study adopted a predictive correlational research design to examine the statistical relationships between cognitive ability, study habits, and academic achievement in Biology. The design was consistent with the examination of relationships among measured variables described by Nworgu (2015). Cognitive ability and

study habits were the predictor variables, and cumulative Biology examination scores constituted the outcome variable. The study was conducted in Awka South Local Government Area of Anambra State, Nigeria.

The population comprised 2,815 Senior Secondary II students offering Biology in 20 public secondary schools in Awka Education Zone, consisting of 1,201 male and 1,614 female students. The population figures were obtained from the Statistics Unit of the Post Primary Schools Service Commission, Awka Zone, in March 2026. The sample comprised 100 Senior Secondary II Biology students from 10 public secondary schools in Awka South. A multistage sampling procedure incorporating purposive, proportionate stratified, and simple random sampling techniques was used to select the participants.

B. Instruments and Achievement Records

Data were obtained using the Cognitive Ability Test (CAT), the Study Habit Questionnaire (SHQ), and students' cumulative Biology examination results for the 2024/2025 academic session. The CAT assessed logical reasoning, verbal comprehension, memory, and problem-solving. These dimensions represented cognitive skills relevant to understanding and applying biological concepts.

The SHQ assessed time management, reading and note-taking practices, concentration, revision patterns, motivation, and examination preparation. Responses were recorded on a four-point Likert scale ranging from Strongly Agree to Strongly Disagree. Students' academic achievement was measured using their cumulative Biology examination scores for the 2024/2025 academic session.

C. Instrument Validation and Data Collection

The CAT and SHQ underwent face and content validation by experts in Educational Psychology, Measurement and Evaluation, and Biology Education. The experts examined item clarity, relevance to the study variables, and suitability for the students' educational level. Their comments informed revisions before administration.

A pilot study was conducted with Senior Secondary II students in a school outside the study area with characteristics similar to the sampled schools. Internal consistency was assessed using Cronbach's alpha for the SHQ and the Kuder–Richardson Formula 20 for the CAT. The instruments were administered directly to the sampled students, and completed responses were collected immediately after administration. Cumulative Biology examination results were obtained as the measure of academic achievement.

D. Data Analysis

Simple linear regression was used to examine cognitive ability and study habits separately as predictors of Biology achievement. Multiple linear regression was used to examine their joint prediction of achievement. Correlation coefficients and coefficients of determination (R^2) summarised the strength of association and the proportion of achievement variance explained by each model. Unstandardised coefficients (B) and standard errors (SE) described the direction and precision of the predictor estimates. Coefficient significance was evaluated using the t distribution, and overall significance of the joint model was assessed using the F statistic. The residual degrees of freedom were 98 for each simple regression and 97 for the multiple regression. Null hypotheses were rejected when $p < 0.05$.

3. RESULTS AND DISCUSSION

A. Cognitive Ability as a Predictor of Biology Achievement

The first research question examined the predictive relationship between cognitive ability and students' academic achievement in Biology. Table 1 presents the simple regression results.

Table 1. Simple regression of Biology achievement on cognitive ability

Predictor	r	R^2	B	SE	p
Cognitive ability	0.203	0.041	0.742	0.362	0.043

Note. n = 100. B = unstandardised regression coefficient; SE = standard error.

Cognitive ability showed a positive relationship with Biology achievement (r = 0.203). The model explained 4.1% of the variance in achievement ($R^2 = 0.041$). The positive regression coefficient (B = 0.742, SE = 0.362) indicated that higher cognitive ability scores were associated with higher Biology achievement scores. The coefficient was statistically significant ($p = 0.043$); therefore, the first null hypothesis was rejected.

The positive relationship is consistent with the role of reasoning, comprehension, memory, and problem-solving in learning Biology. These capacities are relevant when students interpret biological information, connect concepts, and apply knowledge in examinations. The result identifies cognitive ability as a significant predictor of achievement in the sampled students, with the magnitude of its association represented by the observed correlation and explained variance.

This finding agrees in direction with Akinwumi et al. (2023), who reported a positive relationship between mental ability and Biology performance in Ondo State. It also accords with the broader evidence reported by Deary et al. (2007) and Roth et al. (2015) on cognitive ability and educational achievement. Rindermann and Neubauer (2004) similarly examined the relevance of cognitive capacities to school

performance. The present results extend this discussion to cumulative Biology achievement among the sampled students in Awka South.

B. Study Habits as a Predictor of Biology Achievement

The second research question examined study habits as a predictor of Biology achievement. The simple regression results are presented in Table 2.

Table 2. Simple regression of Biology achievement on study habits

Predictor	r	R^2	B	SE	p
Study habits	0.620	0.384	0.931	0.119	< 0.001

Note. n = 100. B = unstandardised regression coefficient; SE = standard error.

Study habits showed a positive relationship with Biology achievement (r = 0.620), accounting for 38.4% of the variance in achievement (R^2 = 0.384). The regression coefficient was positive and statistically significant (B = 0.931, SE = 0.119, $p < 0.001$). Students with higher study-habit scores tended to obtain higher Biology examination scores. Consequently, the second null hypothesis was rejected.

The finding highlights the relevance of organised study practices to Biology achievement. Regular reading, revision, note-taking, concentration, and examination preparation provide ways for students to engage with the subject beyond classroom presentation. In the present study, these practices were represented by the overall SHQ score. The positive coefficient therefore describes the relationship between the measured study-habit score and achievement.

The result is consistent with Ebele and Olofu (2017), who reported a significant relationship between study habits and Biology performance among secondary school students in Abuja. Iqbal et al. (2022) also located study habits within a broader pattern of cognitive engagement in learning. Together, these perspectives support the educational relevance of students' regular learning practices. In the separate regression models of the present study, study habits explained a larger proportion of Biology achievement variance than cognitive ability, with R^2 values of 0.384 and 0.041, respectively.

C. Joint Prediction of Biology Achievement

The third research question examined the joint prediction of Biology achievement by cognitive ability and study habits. Table 3 presents the coefficients for the multiple regression model.

Table 3. Multiple regression of Biology achievement on cognitive ability and study habits

Predictor	B	SE	p
Cognitive ability	0.783	0.280	0.006
Study habits	0.937	0.115	< 0.001

Note. n = 100; R = 0.656; R^2 = 0.430; $F(2, 97) = 36.590$, $p < 0.001$. B = unstandardised regression coefficient; SE = standard error.

The multiple correlation coefficient was R = 0.656, and the two predictors jointly explained 43.0% of the variance in Biology achievement (R^2 = 0.430). The overall regression model was statistically significant, $F(2, 97) = 36.590$, $p < 0.001$. The third null hypothesis was therefore rejected.

Both predictors had positive coefficients in the joint model. Cognitive ability was associated with achievement after accounting for study habits (B = 0.783, SE = 0.280, p = 0.006), and study habits were associated with achievement after accounting for cognitive ability (B = 0.937, SE = 0.115, $p < 0.001$). The combined model explained a greater proportion of achievement variance than either simple regression model.

The joint findings support considering cognitive ability and study habits together when examining students' Biology achievement. Cognitive ability concerns the mental processes used to understand and apply information, while study habits concern the organisation and regularity of engagement with learning tasks. The positive coefficients indicate that each variable retained a predictive association with achievement in the presence of the other. This interpretation is consistent with the cognitive emphasis of Shi and Qu (2021) and the study-practice emphasis of Ebele and Olofu (2017), while remaining grounded in the two-predictor model examined here.

D. Educational Implications

The results support attention to structured study practices alongside activities that engage students' reasoning, comprehension, memory, and problem-solving. Biology teachers can incorporate revision schedules, guided note-taking, and opportunities to explain concepts into routine instruction. Such practices address the learning behaviours assessed in the SHQ and the cognitive skills represented in the CAT. The larger explained variance in the study-habit model provides a basis for giving study organisation a prominent place in academic guidance.

Teachers and school counsellors should help students organise study time, review learning materials consistently, and prepare systematically for Biology examinations. Instructional tasks can also encourage students to explain biological relationships and apply concepts to problems. These recommendations are consistent with the attention to learning processes in Darling-Hammond et al. (2020) and with the study-skills

guidance discussed by Ebele and Olofu (2017). They translate the observed predictive relationships into priorities for instructional support.

4. CONCLUSION

Cognitive ability and study habits significantly predicted secondary school students' academic achievement in Biology in Awka South Local Government Area, Anambra State. Cognitive ability explained 4.1% of achievement variance, whereas study habits explained 38.4% in the separate models. Together, the two variables explained 43.0% of the variance, and both retained positive, significant coefficients in the joint model. The findings establish the relevance of cognitive ability and organised study practices to Biology achievement among the sampled students. Biology instruction and academic guidance should therefore give attention to reasoning and comprehension alongside regular revision, time management, note-taking, and examination preparation.

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