

Cognitive Styles, Self-Efficacy and Motivation as Correlates of Senior Secondary School Students' Academic Achievement in Biology in Osun State, Nigeria

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Abstract

The study assessed the relationship between cognitive styles, achievement-related beliefs, and academic achievement among Senior Secondary School Biology students in Osun State. The study adopted correlational survey research design. Four objectives were raised for the study. The population comprised 64,495 Biology students, from which 540 students were selected from three senatorial districts using multistage sampling. Data were collected using the Biology Cognitive Styles Questionnaire (BCSQ), Achievement-related Beliefs Questionnaire (ARBQ), and Biology Achievement Proforma (BAP), based on students' 2023/2024 academic results. Cronbach's alpha showed reliability indices of 0.76 for motivation and 0.81 for self-efficacy, indicating that the ARBQ was reliable. Findings showed that academic achievement was significantly related to motivation ($r = 0.180$, $p < 0.05$), but not cognitive styles ($r = -0.008$, $p = 0.854$) or self-efficacy ($r = -0.084$, $p = 0.060$). The results also showed a significant joint contribution of cognitive style, motivation, and self-efficacy to students' academic achievement ($F = 5.612$, $p < 0.05$). The study concluded that motivation, rather than cognitive style or self-efficacy, was significantly related to Biology achievement.

Keywords: Cognitive styles, self-efficacy, motivation, and academic achievement

Introduction

Science is the systematic investigation of natural phenomena, aimed at understanding, explaining and controlling natural occurrences for the benefit of humanity. It produces facts, principles, laws and theories through observation, experiment and logical reasoning. Science education therefore matters at every level. It transmits scientific skills, values and knowledge, and it nurtures curiosity, objectivity and critical thinking (Olojo et al., 2022). One of the core areas of science is Biology.

Biology is the life science concerned with living organisms, their evolution, morphology and physiology, and their interactions with the non-living parts of the earth (Onu et al., 2022). A sound understanding of Biology serves as the foundation for further study and careers in medical sciences, health professions, pharmaceutical sciences, environmental biology and biotechnology (Dare et al., 2021). It also underpins plant and animal sciences, agriculture and food sciences (Anyadike & Nwakaire, 2024).

Science encompasses various branches, including physical sciences, earth sciences and life

sciences. Among these, Biology occupies a crucial position as a life science concerned with the study of living organisms and the associated processes. Onu et al. (2022) defined Biology as a branch of life sciences that studies living organisms in terms of evolution, morphology and physiology and their interactions with non-living parts of the earth.

Students' achievement in Biology nonetheless remains a concern (Abidoye et al., 2023; Omotayo & Osuala, 2022; Owolade et al., 2022). Academic performance in the sciences has not been encouraging over the years, especially in WAEC, despite various educational improvements the government, such as financing and provision of instructional materials to popularise science in secondary schools. (WAEC, 2009, 2010, 2011, 2012, 2013, 2014, 2015 & 2016).

In 2021, only 32.6% of public-school candidates in the state obtained five credits including

English Language and Mathematics, which placed it 36th among the states and the FCT (NBS, 2021). Poor achievement of this kind can shrink the pool of students entering health, agriculture, environmental and biotechnology programmes (Owolade et al., 2022; Ojo et al., 2023; Josiah & Oguoko, 2025),

Research on poor Biology achievement has focused mainly on family, socio-economic, school and environmental factors (Balarabe et al., 2019; Sakingobir et al., 2022; Abidoye & Omotayo, 2023; Mohammad & Salisu, 2025). However, learner-related cognitive and psychological factors have received less attention (Kramer et al., 2025).

Cognitive style, consisting of field dependence and field independence (FI-FD), has been shown to influence learning (Ansyah, 2021; Chuang et al., 2021), and a study in Anambra State found that it predicted Biology achievement (Ewendo & Okoli, 2024). Self-efficacy has been linked to academic achievement (Retnama & Babu, 2024; Ugwuanyi et al., 2020). Academic motivation can be seen as a key correlate of performance (Rodriguez et al., 2017; Sharma & Ranjan, 2018), and a Kano study reported significant relationships between achievement motivation and Biology performance (Kayyu, et al., 2021).

However, a Rivers State study found no significant relationship between FI-FD and students' achievement ($r = 0.062$) (Ahiauzu, 2017), and a Katsina study found that it did not significantly predict Physics performance (Yahaya, et al., 2025). A study in Ebonyi State reported no significant relationship between self-efficacy and Biology achievement (Attamah & Okoli, 2021), and an Enugu study found that motivation, but not self-efficacy, influenced Physics achievement (Onah et al., 2022). In Anambra State, self-motivation predicted Biology achievement positively but not significantly (Chukwuemeka, 2025). These studies differ in subject, sample and instrument, and most examined one variable at a time.

To the researcher's knowledge, none examined cognitive style, self-efficacy and academic motivation together in relation to Biology achievement, and none was conducted in Osun State. The one Osun Biology study located examined instructional materials, with 40 students in a single local government area (Awolaju, 2016). Teachers and curriculum planners in the state therefore have no local evidence on how learner characteristics relate to Biology achievement.

One such student-related factor is cognitive style, which has been confirmed in literature to influence learning (Ansyah, 2021; Chuang et al., 2021). Cognitive style characterises an individual's way of solving problems, making decisions, receiving, perceiving and processing information (Nugroho, 2023). Students may differ in how they analyse details, focus on the overall picture, reflect before responding or respond quickly. These differences may influence how learners understand concepts, approach tasks and perform academically.

Several cognitive style models have been developed, including "Integrated, Intuitive, Split, Systematic and Undifferentiated models" (Hooda & Devi, 2017). However, one of the most frequently used is the FI-FD framework developed by Witkin et al. (1977), as cited by Khodadady et al. (2016). It categorises individuals as field-dependent (FD) and field-independent (FI). Field-dependent individuals tend to be sociable and work together, whereas field-independent individuals tend to deconstruct situations independently and may dislike group work (Olagbaju, 2020). Apart from these, there is the ambivert/normal/neutral cognitive style. An ambivert falls between introversion and extroversion and can exhibit characteristics of both field-dependent and field-independent cognitive styles (Petric, 2020).

Gharghani et al. (2019) showed that motivation, self-efficacy, and cognitive and metacognitive strategies are important factors that could determine students' achievement. Motivation refers to the internal stimulus that encourages individuals to strive to excel and fulfil their objectives. Academic motivation serves as another important component of performance (Rodriguez et al., 2017) and encourages learners to work harder, establish competitiveness and complete academic tasks successfully and on time (Sharma & Ranjan, 2018).

While motivation encourages students to develop goals, persist in their studies and overcome challenges, self-efficacy represents the sureness of ability by one to perform. Students with high self-efficacy have a better propensity to strive for high grades, use effective study methods and persevere when tasks become difficult (Retnama & Babu, 2024). Conversely, low self-efficacy may result in reduced motivation, avoidance behaviour, procrastination and lack of interest in academic activities (Ugwuanyi et al., 2020).

However, there is a dearth of studies combining cognitive styles, with factors such as

motivation and self-efficacy in explaining students' academic achievement. This gap prompted the researcher to investigate these variables as relates to Biology secondary school students' learning outcomes in Osun State.

Although studies have investigated factors relating to poor performance in Biology by the students (Balarabe et al., 2019; Sakingobir et al., 2022; Abidoeye & Omotayo, 2023; Mohammad & Salisu, 2025), there appears to be limited evidence on the relationship between cognitive styles, motivation and self-efficacy and academic achievement. Since cognitive styles and achievement-related beliefs relates to student learning outcomes (Gharghani et al., 2019; Kramer et al., 2025), this study therefore investigates their relationship with academic achievement in senior secondary school Biology.

Research Objectives

1. Assess the relationship between cognitive styles and academic achievement in Biology among Senior Secondary School (SSS) students in Osun State
2. examine the relationship between self-efficacy and academic achievement in Biology among SSS students in Osun State
3. determine the relationship between motivation and academic achievement in Biology among students in Osun State
4. Determine the relative and joint relationship of cognitive styles (CS), self-efficacy (SE), and motivation on academic achievement in Biology among students in Osun State

Research Hypothesis

- Ho1: There is no significant relationship between cognitive styles and achievement of students in Biology in the study area
- Ho2: There is no significant relationship between SE and achievement of students in Biology in the study area
- Ho3: There is no significant relationship between motivation and achievement of students in Biology in the study area
- Ho4: There is no significant relative and joint contribution of CS, motivation and SE on achievement of students in Biology in the study area

Methodology

The study adopted the correlational survey research design. The population included all 64,495 students in secondary schools in Osun state as at 2023/2024 academic session. Using sample size calculator, by Taro Yamme Formulae for Sample size calculation, a minimum sample size of 398 respondents was obtained for the study. The sample for the study comprised of 540 Biology students which were selected from all the three senatorial districts in Osun state using multistage sampling procedure. Three Local Government Areas (LGAs) were selected using simple random sampling technique from each senatorial districts, three senior secondary schools were then randomly selected, making a total of 27 schools. From each of the selected schools, 20 Biology students in SSII were selected using simple random sampling technique making a total of 540 students. SS II were selected because they have learnt the foundational courses in Biology and were preparing for the terminal class for the secondary school education in Nigeria, making them fit for the application of the findings of the study. The selection of 20 students per school was made to ensure balance amongst the schools selected and to enable ease in the administration of the research instruments in the sampled schools. This, however, meant that even though there was equal representation of the selected schools in terms of the number of students sampled, there may be an imbalance in representation since the number of students in each of the sampled schools may not be equal.

Three research instruments were used for data collection: the Biology Cognitive Styles Questionnaire (BCSQ), Achievement-Related Beliefs Questionnaire (ARBQ), and Biology Achievement Proforma (BAP). The BCSQ was based on Oltman et al. (1971), titled 'Group Embedded Figure Test', and was used to determine students' cognitive styles. Each correctly traced figure earned one point, with scores of 0–9 indicating FD and 10–18 FI cognitive styles. The ARBQ was adapted from Tuan et al. (2005) and Conradty and Bogner (2022) to measure students' motivation, while the self-efficacy section was adapted from the General Self-Efficacy Scale of Schwarzer and Jerusalem (1995). Both sections used a four-point Likert scale. The BAP was used to collect students' Biology scores for the last three terms as their academic achievement scores. The instruments were subjected to face and content validation. A pilot test was conducted with 30 students outside the study

area. Cronbach Alpha showed reliability indices of 0.76 for motivation and 0.81 for self-efficacy, indicating that the ARBQ was reliable.

For data collection, permission was obtained from the selected schools, and two research assistants

were trained. Biology teachers were informed about the study, after which students' Biology scores were collected using the BAP. Data were analysed using IBM SPSS Version 27 with correlation and regression analysis.

Results and Discussion

H01: There is no significant relationship between cognitive styles and achievement of students in Biology in the study area

Pearson Product Moment Correlation Coefficient (PPMC) was used to test for the relationship between cognitive styles and academic achievement of the respondents. The cognitive style scores and academic achievement scores were used as continuous variables, making PPMC an appropriate statistical test.

Table 1: PPMC of Cognitive Styles and Academic Achievement

	N	Mean	r	P
Cognitive Style	500	15.65	-.008	.854
Academic Achievement		57.70		

The Table shows that there is no significant relationship between academic achievement and cognitive styles ($r = -0.008$, $p=0.854$). The r value shows that the relationship between these variables was weak and negative; hence, the null hypothesis was not rejected.

H02: There is no significant relationship between self-efficacy and achievement of students in Biology in the study area

The cumulative continuous score for academic achievement was used for the analysis. This

was gotten by finding the average scores for the three terms, as gotten from the proforma. A questionnaire on self-efficacy was administered on the respondents. The questionnaire was scored from 4-1, that is, SA-SD respectively. The score of each of the responses to the 17 questionnaire items were summed up to represent a measure of self-efficacy. Pearson Product Moment Correlation Coefficient (PPMC) was used to test for the relationship between self-efficacy and academic achievement of the respondents as presented in Table 2.

Table 2: PPMC of Self-Efficacy and Academic Achievement

	N	Mean	R	P
Self-Efficacy	500	51.29	-.084	.060
Academic Achievement		57.70		

There is no significant relationship between academic achievement and self-efficacy of the respondents ($r = -0.084$, $p = 0.06$). The r value shows that the relationship between these variables was weak and negative; hence, the null hypothesis was not rejected.

H03: There is no significant relationship between motivation and achievement of students in Biology in the study area

Similarly, a questionnaire on motivation was administered on the respondents. The questionnaire was scored like that for motivation. The score of each of the responses to the questionnaire items were summed up to represent a measure of the motivation. PPMC was used to test for the relationship between motivation and academic achievement of the respondents as presented in Table 3.

Table 3: PPMC of Motivation and Academic Achievement

	N	Mean	R	P
Motivation	500	56.56	.180	.001
Academic Achievement		57.70		

There is a significant relationship between the academic achievement of the respondents in Biology and the motivation of the respondents ($r = 0.180$, $p < 0.05$). Hence, the null hypothesis was rejected. The relationship was, however, weak and positive.

H04: There is no significant relative and joint contribution of cognitive styles, motivation and SE on

the achievement of students in Biology in the study area

Regression analysis was used to find the relative and joint of cognitive style, motivation and self-efficacy on the academic achievement of students in Biology.

Table 4: Regression Analysis of Influence of cognitive style, motivation and self-efficacy

Model		Sum of Squares	Df	Mean Square	F	Sig.
R = 0.181	Regression	2091.638	3	697.213	5.612	.001 ^b
R ² = 0.033	Residual	61618.154	496	124.230		
Adj R = 0.027	Total	63709.792	499			

a. Dependent Variable: Achievement

b. Predictors: (Constant), Efficacy, Cognitive, Motivation

The regression analysis of the influence of cognitive style, motivation and self-efficacy on the academic achievement of students in Biology in the study area is presented in Table 4. The Table shows a significant joint contribution of cognitive style, motivation and SE on the academic achievement of students ($F = 5.612$, $p < 0.05$). However, the multiple

regression coefficient, R, shows that there is a weak influence (18.1%) of cognitive style, motivation and self-efficacy on the academic achievement of students. R² value of 0.033 signifies that only 3.3% of the academic achievement of students in Biology is predicted by the combination of cognitive style, motivation and self-efficacy.

Table 5: Regression Weights of combined influence of cognitive style, motivation and self-efficacy on academic achievement of students in Biology

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	77.409	5.905		13.108	.000
	Cognitive Style	.024	.124	.009	.192	.848
	Motivation	.396	.109	.193	3.635	.000
	Efficacy	.049	.120	.021	.403	.687

a. Dependent Variable: Ave

The regression weight of combined influence of cognitive style, motivation and self-efficacy on academic achievement of students in Biology is presented in Table 5. The table shows that only motivation significantly predicted the academic achievement of students in Biology. Specifically, this means that for each one-unit increase in motivation, academic achievement increases by 0.396.

Discussion of Findings

The result shows that academic performance in Biology is strongly associated with motivation in students but not SE and cognitive style. The implication of this finding is that the level of motivation of students is more important in their accomplishment in Biology than the way they process information and how sure they are about their talents. Also, the extent to which the students have self-belief

that they can study and pass Biology and carry out basic classroom activities. They also have the confidence that they can succeed in Biology, especially in internal examinations and by extension in external examinations. Meanwhile, the not significant correlation with cognitive style suggests that both of the factors on their own might not directly translate into greater achievement unless they are supported by a powerful motivational factor. This aligns with Mbatha (2015), whose findings revealed that there is no significant relationship between the academic achievement of students and self-efficacy. However, they found that academic achievement is not also statistically related to motivation, which is contradictory to the findings of this study. Furthermore, the findings of Motaharinezhad (2016) revealed a similar result when they found that there was a significant correlation between self-efficacy, achievement motivation and academic achievement of students. However, the findings of Idika, (2017) were contradictory when he found that CS of the students was one of the determinants of their academic achievement. The findings of Onyekuru (2015) also revealed a significant difference in the academic achievement of students in different cognitive styles. It was seen that students in the field-dependent style performed better than the students in the field-independent style. Also, the findings of Zhang and Tian (2019) showed that FI students showed a faster reaction time during test-taking than those with a FD style. In addition, the findings of Yarmohammadzadeh and Feizollahi (2016) showed that there is a significant relationship between academic motivation and self-efficacy of high school students. The findings of Kebebe, (2020) also revealed that there is a significant influence of self-efficacy on the academic achievement of students. The study of Ogbonnaya et al. (2024) also revealed that there is a significant relationship between self-efficacy and the academic performance of students in Biology. Udeh-Aloysius & Achufusi (2024) also found a similar result when they said that there was a significant relationship between SE and motivation and academic achievement of students in Biology in Enugu state, however SE had no relationship in this current study.

The findings indicate that Biology achievement is influenced by student characteristics and external factors (Gharghani et al., 2019; Kramer et al., 2025), with the joint model showing an uneven profile, suggesting that the three variables do not have equal influence. This challenges the assumption that

cognitive style, self-efficacy and motivation are each worthy of separate consideration in Biology classrooms as claimed by much of the literature.

Motivation's dominance aligns with the view that it is the continued effort, rather than capability or cognitive style, that differentiates field-dependent and independent learners in a content-heavy subject (Rodriguez et al., 2017; Sharma & Ranjan, 2018). Biology assessment in Nigeria is based around recall and application across many areas, and so students who study persistently may gain more than those who use a special way of processing information. This aligns with the study of Chukwuemeka (2025) who found no significant effect of self-motivation in Anambra State. The difference is likely due to what each study tested, since self-motivation is a narrower concept than the academic motivation measured here, and so the results are not contradictory.

Bandura (1997) views self-efficacy as task-specific, so a general scale underestimates its association with Biology scores. Self-efficacy and motivation are correlated (Ugwuanyi et al., 2020), and when included together in one regression, the effect of self-efficacy may be absorbed by motivation. Self-efficacy may thus mediate motivation, rather than jointly predict achievement.

The non-significance of cognitive style is in line with Witkin et al.'s position (1977) that field-dependence-independence describes how people process information, rather than their overall level. A difference in style should affect achievement only where a task is rewarding to one type. A general Biology test is unlikely to, and so students at both extremes may perform equally well.

The findings point teachers towards motivation-enhancing strategies before matching instruction to cognitive style. The design indicates an association, but not that higher achievement causes increased motivation.

Conclusion

The study concluded based on the findings of the study that there is no significant relationship between cognitive styles and the academic achievement of students in Biology. Furthermore, the study concluded that only motivation was found to be have a significant relationship.

Recommendations

Based on the findings, curriculum planners and Biology teachers should provide flexible,

inclusive and adaptable learning experiences for students with different cognitive styles. Psychological interventions should be used to enhance students' motivation and confidence. Biology teachers should also use positive feedback, goal setting, mastery-based tasks and relatable real-life cases to improve self-efficacy and intrinsic motivation. Guidance counsellors and school administrators should provide support programmes that promote positive motivation and self-efficacy, persistence and resilience. Furthermore, teachers should prioritise interesting teaching methods, relevant learning activities and reward systems that encourage effort and perseverance.

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