

Research Article

Path Analysis of Students' Cognitive Style, Interest and Attitude on Their Academic Achievement in Biology in Nsukka Education Zones of Enugu State

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Abstract: Using path analytic method, specifically the study established the path relationships amongst students' cognitive style, interest, attitude and their academic achievement in Biology. Three research questions were raised and answered. The population of the study comprised 9367 Biology students in SS1-3 of 2018/2019 academic session. A sample of two hundred and forty-four (244) respondents comprising of both males and females was used. Data were collected using four instruments; Group Embedded Figure Test (GEFT), Biology Interest Scale (BIS), Biology Attitude Scale (BAS) and a proforma for collection of student academic achievement in biology. BIS and BAS were developed by the researcher and were appropriately validated by three Measurement and Evaluation experts from Department of Science Education from University of Nigeria Nsukka. Reliability coefficient of BIS and BAS were 0.88 and 0.78 respectively while that of GEFT was 0.82 as established by the author. Using the data collected research questions were answered using multiple regression analysis with Analysis of Moment Structure (AMOS) which is path analytic statistical software. Research question one and two were answered using the arrow headed lines in the path diagram, path coefficient and goodness of fit index and RMSEA. Research question three was answered using parameter estimate from IMB AMOS and percentage. The findings of the study showed that: the most meaningful causal model for providing explanation of the achievement of students in biology is recursive model involving FI cognitive style, FD cognitive style interest and attitude. FD cognitive style was included in the model because it has significant path with attitude; the significant path through which the independent variables caused variation in students' achievement in Biology are those of field independent cognitive style and interest; FI and interest had direct significant path with achievement in biology. FI and FD cognitive style also had direct path relationship with attitude which is significant; and FI-Attitude-Interest had no significant indirect path with students' achievement in biology, also in a total influence of 0.96 of the predictor variables (cognitive style interest and attitude) on the criterion variables (achievement) 72% was direct while 28% was indirect. It was recommended among others that parents, teachers, curriculum planners and all education stakeholders should reward students who show positive attitude to their studies in form of scholarship, award or prizes to encourage those who are really studying hard.

Keywords: Path Analysis, Cognitive Style, Interest, Attitude, Academic Achievement, Biology

How to cite this article: Ugwuekpe JL, Abonyi AS, Anugwo AM, Ugwuabo AN, Ikeh FE. Path Analysis of Students' Cognitive Style, Interest and Attitude on Their Academic Achievement in Biology in Nsukka Education Zones of Enugu State. Research Journal of Humanities and Social Sciences. 2025 Aug 19 ;4(4): 112-122

Source of support: Nil.

Conflict of interest: None

DOI:doi.org/10.58924/rjhss.v4.iss4.p15

Received: 05-08-2025

Revised: 08-08-2025

Accepted: 14-08-2025

Published: 19-08-2025



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1. Introduction

Biology is the science that seeks to understand the living world. It is the study of the microscopic structure of cell, the study of the global interaction of millions of organisms, the history of individual as well as the collective history of organisms. A student who wishes to excel in disciplines like medicine, pharmacy, nursing, biochemistry, microbiology and Agriculture must strive to develop power of critical observation and descriptions which are part of the thinking processes underlying scientific enquiry. Igboanugo (2013) explained that biology is the prerequisite subjects for many fields of

learning that contribute immensely to the technological growth of the nation. Study of biology in senior secondary school can equip students with useful concepts, theories and knowledge which enable them to face challenges of life after secondary education. The secondary school biology curriculum is concentric in nature which means that each topic is taught throughout the three years in senior secondary but in different degrees. The cardinal objectives of Biology syllabus as derived from senior secondary education curriculum by the Federal Ministry of Education (2009, p.1) are to; prepare pupils acquire adequate laboratory and field skills in biology; help students acquire meaningful and relevant knowledge in biology; help student, develop the ability to apply scientific knowledge to everyday life in matters of personal, community health and agriculture; help students acquire reasonable and functional scientific attitude.

The federal and state governments have been making effort to ensure that these goals are actualized by providing scientific equipment for schools at federal and state level and also training and retraining of science teachers on how to boost students interest and achievements in sciences especially biology. In spite of the effort made by Nigeria government to promote a sound educational policy, the schools appear to have failed to meet the nation's expectation especially in science with particular reference to biology. In spite of the importance of biology to the national development, biology results in most certified examination like senior secondary certificate examination (SSCE) conducted by West African Examination Council (WAEC) and National Examination Council (NECO) have not been satisfactory in Nigeria (WAEC Chief examiners report 2018). The uninspiring achievement of students in the WAEC examination especially in Biology spurs the need to investigate if students' achievement in biology could be predicated from their interest, attitude and cognitive style using path analysis.

According to Bingham (2018) interest is a feeling of likening associated with a reaction either actual or imagined to a specific thing or situation. A person may be interested in something when he sees that such a thing will be of benefit to him. Interest provides in human beings a strong motivation to learn. According to Kpolovie, Joe and Okoto (2014) a significant relation exist between students' interest towards learning and students' academic achievement in science. They are of the view that individual interest is characterized by an intrinsic desire to understand a particular topic that persist over time while situational interest is assumed to be transitory, environmentally activated and content specific. However, it is observed that the kind of interest developed by biology students towards biology is related to the degree and direction of students' attitude towards biology (Ugwugbo, 2016).

Attitude influence an individual's choice of action and response to challenges, incentives and reward collectively called stimuli. It can be referred to as a person's viewpoint, mindset or belief. Illyasu, Lee and Yahaya (2015) are of the opinion that attitude play an important role towards the future of science students. They are of the view that students' attitude towards science affect their academic performance. According to Badamasi (2015) attitude do not consist of a single unitary construct but rather consist of large number of sub-construct all of which contribute in varying proportion towards an individual's attitude to science. The idea of individual differences in mode of processing information has spurred up the researcher's feeling that cognitive styles could influence interest and attitude of students in biology. According to Sellah and Mondah (2018), cognitive style is a term used to describe the way individuals perceive, think and remember information. Cognitive styles as a concept is a component of a larger concept termed as learning styles. Adegoke (2011) reported that cognitive psychologist and educators have been interested in understanding the individual differences in cognition

and their impact on learning and instruction. This is clear evidence that research on the issue of cognitive style is still open. As a result, this research effort tends to investigate students' academic achievement based on their cognitive style, interest and attitude using path analytic method.

Academic achievement can be seen as a technique for the measurement of accomplishment of skills in various field of academic study. Describing achievement (Ricada, Anja, Weidinger and Wirthwein, 2014) in their opinion described achievement as a systematic and purposeful quantification of learning outcome. They maintained that academic achievement represents performance outcome that indicate the extent to which a person has accomplished specific goal that were focus of activities in instructional environment specifically in schools, colleges and university. Considering the magnitude of the under achievement as well as plethora of factors that give rise to the situation, it has become necessary to explore students' achievement through their cognitive style, interest and attitude using path analytic method.

However, Path analysis is a statistical technique used to examine the comparative strength of direct and indirect relationship among variables. The aim of path analysis according to Akobi (2014) is to provide estimate of the magnitude and significance of hypothesized causal connection among a set of variables displayed through the use of path diagrams. This research effort intends to explain explicitly the relationships between students' cognitive style, interest and attitude on their academic achievement in biology through the use of path analysis. Although some studies have been carried out on the relationship between students' interest and academic achievement in biology, most of the studies were done based on simple correlation or multiple linear regression. These approaches are not capable of determining both the direct and indirect effect of the independent variables on students' achievement in biology. There is dearth of empirical evidence to support the fact that students' achievement could be predicted from their cognitive style, interest and attitude using path analysis. The problem of this study posed as a question therefore is what is the path analysis for providing an explanation of the achievement of students in biology based on their cognitive style, interest and attitude towards biology?

Purpose of the Study

The main purpose of the study was to develop a causal model for the explanation of the influence of variables (cognitive style, interest and attitude) on students' academic achievement in biology. Specifically, the study sought to:

1. Developed the causal model for providing an explanation of students' academic achievement in biology based their cognitive style, interest and attitude.
2. Determined the estimate of strength of causation (path coefficient) of the variables (cognitive style, interest and attitude) on the model.
3. Determine the direct and indirect effect of the variables (cognitive style, interest and attitude) on students' academic achievement in biology and their percentages.

Research Questions

The following research questions guided the study;

1. What is the most meaningful path model for explaining the influence of the variables (cognitive style, interest and attitude) on students' academic achievement in biology?
2. What are the estimates of strength of causation (path coefficient) of the variables (cognitive style, interest and attitude) on students' academic achievement that are significant and those that are not significant?

3. What are the direct and indirect effects of the variables on students' academic achievement in biology and their percentages?

2. Methodology

Correlational survey design was adopted for the study. This study was carried out in Nsukka education zones of Enugu state. The population of this study comprised all senior secondary school biology students in public (Government owned) school in Nsukka education zone in 2018/2019 academic year numbering nine thousand three hundred and sixty-seven (9367). The sample size for the study was 244 respondents of biology students. A multi-stage sampling procedure was adopted to compose the sample of the study. Four instruments were used for the study to collect relevant data, they are; Group Embedded Figure Test (GEFT), Biology Interest scale (BIS), Biology Attitude Scale (BAS) and Form for collection of students' third term result (achievement) in Biology. Reliability coefficient of BIS and BAS were 0.88 and 0.78 respectively while that of GEFT was 0.82 as established by the developer. Research questions were answered using multiple regression analysis with Analysis of Moment Structure (AMOS) which is path analytic statistical software. Research question one and two were answered using the arrow headed lines in the path diagram, path coefficient and goodness of fit index and RMSEA. Research question three was answered using parameter estimate from IMB AMOS and percentage

3. Results

Research Question One

What is the meaningful path model for explaining the influence of the variables (cognitive style, interest and attitude) on students' achievement in Biology?

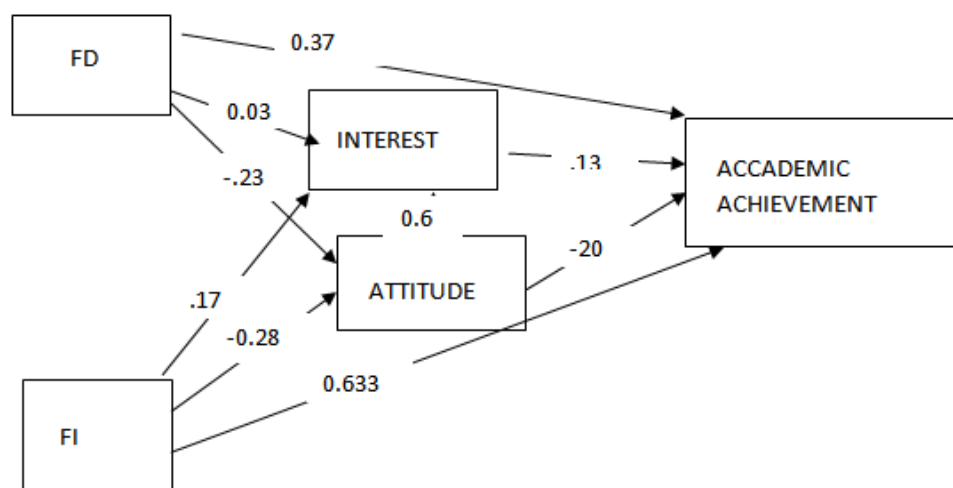


Figure 1: Meaningful Path Model for explaining the Influence of Students' Cognitive Style Interest and attitude on their Academic Achievement in Biology

The main model fit indices of the developed model in the path diagram above as computed by the path analysis software are as follows:

- (1) Comparative fit Index (CFI) of the default model in 0.92. Acceptable model is the one that has CFI value greater than 0.90 (.). Hence the default model is good and acceptable.
- (2) Normed Fit Index (NFI) of the default model is 0.90. NFI value between 0 and 1 is a good fit. The closer NFI to 1 the better fit. Since the NFI is 0.90 the default model is good (.). Hooper, D., Coughlan, J., & Mullen, M. R. (2008).

(3) Root Mean Square Error of Approximation (RMSEA) of the default model is 0.06 RMSEA value between 0.05 and 0.08 are acceptable. The RMSEA of the default model is 0.06 which indicate that the model is good (Hooper et al., 2008).

(4) Goodness of Fit Index (GFI) of the default model is 0.91. A GFI value greater than 0.90 is said to be a good fit (Hooper et al., 2008) since the GFI value of the default model is 0.91 the model is good.

From the figure 1, it can be seen that a recursive model was developed. The model is recursive because some variables that are exogenous for the endogenous variable (achievement) were seen to be endogenous to other exogenous variables.

$$Y = a + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4$$

$$Y = a + 0.23X_1 - 0.28X_2 + 0.62X_3 + 0.13X_4 \text{ (observed model)}$$

Where Y = dependent variables which achievement

a = regression constant

X₁ = FI cognitive style

X₂ = FD cognitive style

X₃ = Interest

X₄ = attitude

The analysis revealed that FD cognitive style did not have significant relationship with the endogenous variables achievement but was included in the path diagram because it had significant relationship with attitude. The model fit indices of CFI, NFI, RMSEA and GFI as listed above showed that the developed model is very good as all the indices indicated good model fit. Hence the developed meaningful path model of students' cognitive style, interest and attitude on achievement in Biology is a very good model as indicated by its model fit indices. There is no significant fit model between the theoretical proposed model and the developed model.

Research Question Two

What are the estimates of strength of causation (Path coefficient) of variables (cognitive style, interest and attitude) on students' academic achievement in Biology that are significant and those that are not significant?

Table 1: Path Coefficient (Regression Weights of the Default Model)

Path	(Estimate)	SE	P
Path coefficient			
FD <.....Academic Achievement	0.37	0.11	.21
FI <..... Academic Achievement	0.63***	0.09	.001
FD <.....Interest	0.03	0.10	.33
FD <.....Attitude	-0.23	0.09	.05
FI <.....Interest	0.17	0.11	.33
FI <.....Attitude	-0.28*	0.28	.05
INT <.....Academic Achievement	0.13	0.11	.05

Source: Researcher's Fieldwork (2022)

The result in Table 1 revealed that the following path coefficients are significant;

1. From FD to attitude with path coefficient of 0.23 is significant based on its p-value that is less than 0.05.
2. From FI to attitude with path coefficient of -0.28 is also significant.
3. The path from FI to academic achievement with path coefficient of 0.63 with p-value that is less than 0.001 is significant.
4. Also the path from attitude to interest with path coefficient of 0.62 with p-value less than 0.001 is significant.
5. The path from interest to academic achievement in biology with path coefficient of 0.13 with p-value less than 0.05 is significant.

The significant paths showed significant relationship between the variables. This means that FI cognitive style has a significant relationship with attitude and academic achievement in Biology. Also attitude has a significant relationship with interest. Finally, interest has a significant relationship with academic achievement in biology with respect to the developed model. The Table also revealed that the following paths with their corresponding path coefficient are non-significant.

1. The path from FD academic achievement with path coefficient of 0.37 with p-value .21 which greater than 0.05 is non-significant.
2. The path from FD to interest with path coefficient of 0.03 p-value .33 which greater than 0.05 is non-significant.
3. The path FI to interest with path coefficient of 0.17 with p-value .33 which is greater than 0.05 is non-significant.
4. The path from attitude to academic achievement with path coefficient of -0.20 with p-value .46 which is greater than 0.05 is non-significant.

The paths that are non-significant showed that there is no-significant relationship between those variables. This means that FD cognitive style have no significant relationship with academic achievement and interest in Biology. Also FI cognitive style has no significant relationship with interest. Also there is no significant relationship between attitude and academic achievement in biology based on the paths of the developed model.

Research Question Three

What are the direct, indirect and total effects of cognitive style, interest and attitude on students' academic achievement in Biology and their percentage?

Table 2: Direct effect of variables (cognitive style, interest and attitude) on academic achievement in Biology

S/N	Path	Direct effect	P-value	% of Direct Effect
1.	FD to Academic Achievement	0.37	.21	38.54
2.	FI to Academic Achievement	0.63***	0.00	65.62
3.	FD to Interest	0.03	.33	3.12
4.	FD to Attitude	0.23*	0.05	-23.95
5.	FI to Interest	0.17		17.70
6.	FI to Attitude	-0.28*	0.05	-29.16
7	INT = Academic Achievement	0.13	0.05	
8	Attitude to Academic Achievement	-0.19		
	Total			71.95%

Table 3: Indirect effect of the Variables (Cognitive Style Interest and Attitude on Student Achievement in Biology

S/N	Path	Indirect effect	P-value	% Indirect Effect
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1.	FD-Int-Academic Achievement	0.04	4.16
2.	FD-Att-Academic Achievement	0.19	19.79
3.	FI-Int-achievement	-0.32	-33.33
4.	FI-Att-Academic Achievement	0.36	37.95
	Total		28.12%

From the Table 2, it is shown that the direct effect of paths between FI to achievement and interest, and the direct path between FD and attitude biology are significant. On the other hand the direct effect of path between FD and achievement and FD and interest and between FI and interest are non-significant as they have p-value greater than 0.05. Also the indirect effect as seen from the table 3 showed that the indirect path FD-Interest achievement, FI-attitude-achievement, FD-attitude-achievement and FI-interest-achievement are non-significant as they have p-values greater than 0.05. Table 2 and 3 showed the percentage direct and indirect effect of students' cognitive style interest and attitude on their academic achievement in Biology. Table 2 showed that field independent cognitive style has the strongest percentage (65.62%) of direct effect to students' achievement in biology while attitude has -23.95% effects to FD cognitive style and -29.16% effects to FI cognitive style respectively. The percentage of the causal effect that was direct was 72%. This implies that 72% of students' academic achievement in biology is accounted for by the direct effect of students' cognitive style interest and attitude towards biology.

Similarly, table 3 showed that the indirect path field independent- attitude- achievement has the strongest percentage of 37.95% while the path FI-Interest-Achievement has -33.33%. Meanwhile the total percentage of the indirect effect of the variables (cognitive style interest and attitude) on achievement was 28.13%. This means that 28% of the total achievements of students in Biology are accounted for by the indirect effects of the variables (cognitive style, interest and attitude).

4. Discussion of Findings

Explanation of the Achievement of Students in Biology based on their Cognitive Style, Interest and Attitude to Biology

The finding of the study showed the most meaningful causal model for explaining the achievement of students involving field independent cognitive style, interest and attitude. The data used for the study fit the model. The model fit indices as listed above indicated a very good model fit with the observed data. The path diagram showed paths with their corresponding path coefficients. The model showed the direct and indirect effect of the variables on students' achievement in biology. Among the variables for the study FI, interest and attitude had significant influence on students' achievement in Biology. FD cognitive style and attitude do not have significant influence on students' achievement in biology. The implication of the developed model to education is that students' achievement in biology is determined by some variables like cognitive style, interest and attitude that can either affect it directly or indirectly. This shows that for improvement in students' achievement in biology to occur these variables must be considered during the process of teaching and learning.

The result agrees with the finding of Adigwe (2013) who found that cognitive style, formal reasoning ability and sex had significant influence on students' achievement in the bonding and structure in chemistry. Also it agrees with the finding of Wagbara 2015 whose finding revealed that cognitive style have significant influence on mean score of

students in practical skill. The finding also disagrees with the finding of Sakarriyauet al. (2016) whose finding showed that a higher proportion of students display positive attitude towards science. However, the finding is in consistence with the finding of Ugwuanyị (2016) which showed that the most meaningful causal model for providing an explanation for students' achievement' in physics is the recursive model involving family background of students' qualification of teachers', students' attitude to physics, professional development and classroom practice.

Estimate of the strength of Causation Path Coefficient of the Variables (Cognitive Style Interest and Attitude) in the Model

The findings on the study as presented in table 1 showed the paths with their corresponding path coefficient and p-values to test the path significance. The result showed that five paths out of nine paths of the study are significant while the remaining four are non-significant. The causal paths are the paths between FD and achievement, FI and achievement, FD and Interest, FD and attitude, FI and interest, FI and attitude, attitude and interest, interest and achievement. The result showed that only interest had significant path with students' achievement in Biology.

Also the result showed that there is significant path between FD and Attitude, FI and Attitude and between Attitude and Interest. These variables influence achievement and on the other hand are being influenced by other variables. This implies that students' achievements in biology are influenced by the variables cognitive style, interest and attitude and should be considered while planning students' instruction. The result agrees with the finding of Ugwuanyị 2016 & Akobi (2014) that in their studies developed a recursive model.

Direct and Indirect Influence of the Variables (Cognitive Style, Interest and Attitude) on Students' Achievement in Biology and Percentage (%) of Total Influence that were Direct and Indirect

The finding as presented in table 2 and 3 respectively showed the direct and indirect influence with the percentage of the total influence that is direct and indirect. The result showed that FI, FD, Interest and Attitude had direct path with achievement in Biology. Among these variables only FI and interest had significant direct path with achievement. Similarly, FI and FD had direct path with interest and attitude. FD had significant path with attitude but non-significant path with interest. On the other hand, FI had significant path with attitude and had non-significant path with interest. Attitude had direct path with interest. This implies that these variables (cognitive style, interest and attitude have relationship with each other and cannot be excluded while planning instruction for students. There was also indirect influence of these variables on students' achievement in biology. The result was in agreement with the findings of Brymom & Crammer (1990), Akobi (2014) & Ugwuanyị (2016) who observed similar causal relationship between variables of their study.

From the table 2 and 3 the total influence of the variables both direct and indirect was 0.96 out of the 0.96 influence of the variables on the achievement of students in Biology, 72% influence was direct while 28% influence was indirect. The result equally showed the individual influence of the predictor variables on the criterion variable. FI cognitive style had the strongest influence of 65.62% on direct influence on achievement while FD cognitive style had the least influence -23.95% on attitude. This implies that cognitive style of students influences their achievement in biology and therefore accounts for

variability in their achievement. However, FI cognitive influences more than FD cognitive style. This result is in consistency with the finding of Ugwuanyi (2016) who in his own study found that students' attitude had direct and indirect influence on students' achievement in physics.

5. Recommendation

The following recommendations are made based on the findings of the study

1. Federal and state ministries of education should organize seminar, workshop and training for biology teacher to equip them with skills for identifying students' cognitive styles and plan their instructions in line with the students' cognitive styles.
2. Since students' cognitive style is positively associated with their academic achievement in biology, biology teachers should emphasize more on activities that accommodate students with different cognitive style students' thereby improving in their academic achievement in biology.
3. Parents, teacher, curriculum planners and all education stakeholders should reward students who show positive attitude to their studies in form of scholarship, award or prizes to encourage those who are really studying hard.
4. Teachers training colleges and universities should reform and revise their curriculum to emphasize on students' cognitive style, interest and attitude while training teacher to enable them identify students' cognitive styles and interest and plan their instructions accordingly.

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