

Path-Analysis of Factors Affecting Academic Achievement of Tertiary Education Students in Chemistry in Delta State

¹Nwanze, A. Cornelius & ²Okoli, J. Nwanneka

Department of Science Education, Nnamdi Azikiwe University, Awka, Anambra State

E-mail: cinajoyd@gmail.com

Abstract

The study is a path-analysis of factors affecting academic achievement of tertiary education chemistry students in Delta state. Three research questions and one hypothesis guided the study. The design was correlational survey with path-analytic statistical approach. A sample of 200 out of 1,274 two hundred level chemistry students partook in the study. Ten instruments validated by experts and their reliabilities established using Cronbach Alpha were used in the study. Data from the study were analyzed using multiple regression and path analysis. The findings of the study revealed that academic resilience, self-regulated learning skills, test anxiety and study habit were the most significant predictors affecting achievement in chemistry through meaningful and significant paths. The study recommended that diagnostic analysis of student-related variables should be carried out at the point of admission and as the student progress academically.

Keywords: Path-analysis, chemistry, achievement, tertiary, causal-mode

Introduction

The role of science and technology in the improvement of living standard and the development of a nation is vivid. To maximize the benefits of recent advancements in science and technology, nations must seek ways through which the quality of science education can be enhanced. The Nigerian government has continued to revise her policy on education in order to accommodate improved science education, but, even recent reviews have no provision for solid science education at basic education level as compared to the developed nations. No subjects in the field of study of science and mathematics such chemistry, physics, biology, agriculture and computer studies among others which are core to science education were made compulsory. Notably, there has been a continuous decline in the number of students enrolled for chemistry at secondary level of education, given the increasing number of students each year and even at the tertiary institutions (Konyefa & Nwanze, 2020).

Chemistry as a science subject deals with understanding the composition, properties, synthesis and uses of matter (Ababio, 2011). At the secondary as well as tertiary levels of education, the study of chemistry has been saluted with serious and appalling remarks. The problem of poor achievement at the tertiary level is commonly attributed in literature to the poor understanding of chemistry concepts which students carry to the tertiary institutions. A more disturbing note is that studies directed towards improving on factors implicated for poor achievement in chemistry such as instructional methods have been ongoing. The question that comes to mind therefore becomes: What factors actually predict students' achievement in chemistry?

Factors such as environmental, psychological, social, cognitive, assessment, teacher, school, parent, location or student related have been shown in literature to predict achievement (Hattie, 2009; Kocakaya & Gonen, 2012). Some of such variable include academic resilience, attitude, emotional intelligence, self-esteem, study habit (Bajwa, Gujjar, Shaheen & Ramzan, 2011), test anxiety, self-regulation, interest, motivation, self-efficacy and cognitive style (Mohamed, Mustafa, Abdullah & Hamdan, 2013). Studies have been conducted into the understanding of how

aforementioned factors affect or predict achievement but no in-depth investigation has been carried out with respect to how these factors interact to predict achievement in chemistry. There arise therefore, the need to redirect the focus of research on the causal paths through which the implicated factors predict achievement in chemistry. Thus, the present study is made necessary by the fact that such factors as: test anxiety, motivation, self-efficacy, study habit, attitude, academic resilience, interest, emotional intelligence, self-regulated learning and self-esteem predict achievement not just individually but may interact to predict achievement through different path ways.

Test anxiety according to Eman, Hind, Rufa, Nadiah and Brouj (2016) is an undesirable reaction toward evaluation. Studies show that there exists a relationship between test anxiety and achievement (Ali & Mohsin, 2013; Chukwu, 2014). Ali and Moshin noted that students with high level test anxiety achieve low unlike students with low level test anxiety. They further asserted that when test anxiety is a facilitating anxiety, students with high test anxiety become intrinsically motivated and adopt good study habits in a bid to achieve higher. Motivation according to Izuchi and Onyekuru (2017) is an inner force or desire to achieve a certain goal, a phenomenon consisting of individual's beliefs in ability to carry out a specific task and the emotional responses concerning carrying out the task. Students who are intrinsically motivated are energetic, self-directed, competing and find themselves constrained to learn than those extrinsically motivated (Chelliah & Arulmoly, 2017). Intrinsic motivation according to Dawson-Brew & Nyarko-Sampson (2017) provides sufficient incentive for doing any academic task. Such incentive may however be dependent on the students' confidence in the ability to complete academic task. Thus, motivation may depend on self-efficacy. Self-efficacy according to Yazachew (2013) is the perceived confidence people have in their abilities for success in a given task. Students with high self-efficacy tend to attempt tasks and keep trying even when the task might prove difficult (Maria, 2014). Students' self-efficacy Mishaelides (2008) noted influences the choice and commitment to academic task, and the level of input and performance. The commitments to academic tasks spur students to adopt certain study-habits to ensure success at such tasks.

Study habit is a well-planned and deliberate pattern of study, which has attained a form of consistency on the part of the students towards understanding academic subjects and passing examination (Siahi & Maiyo, 2015). Students who use effective study skills may feel their work and effort is more worthwhile (Osa-Edoh & Alutu, 2012). According to Didarloo, Khalkhali and Rahimi (2013), good study-habit can improve students' ability to learn and result in attitudinal change towards learning.

Attitude according to Oskamp and Schultz (2005), is the predisposition to respond in a favourable or unfavourable manner with respect to a given object. Studies show that attitude affects achievement (Matazu & Julius, 2018; Otekunrin, Oni & Otekunrin, 2017) and may result in academic resilience when positive (Perez, Espinoza, Ramos, Coronado & Cortes, 2009). Resilience is a psycho-social process observed in some individuals that accounts for success despite adversity (Cassidy, 2016). Academic resilience increases the likelihood of success in school despite academic challenges (Mwangi, Okatcha, Kinai & Ileri, 2015) and may heighten and sustain interest to learn no matter the odds. Although, studies show that academic resilience affects achievement (Majid, 2018; Mwangi et al., 2018), it may require students to be of good emotional intelligence since issues of resilience incite emotions.

Emotional intelligence is the ability to identify and regulate emotions by managing, expressing, controlling, understanding and interpreting one's and other's emotions (Barret, 2015). Pioneer researchers such as Mayer and Salovey, Goleman and Zimmaman in the field of emotional intelligence relate that emotional intelligence may be more important than intelligence quotient. This assertion may have proceeded from the idea that students with high emotional intelligence have good skills of self-regulation during learning. Self-regulated learning according to Thomas, Ulrike and Nathan (2013), learning is a form of acquiring knowledge and skills in which learners are independent and self-motivated. Self-regulated students are those students who are metacognitively, motivationally and behaviourally active in their own learning process and in achieving their own goal. Studies have shown that self-regulated learning affects achievement (Ningrum, Kumara & Prabandari, 2018; Sara, Mohamad & Hamid, 2018) and that highly self-regulative students may build up good self-esteem.

Self-esteem is the positive and negative attitude to one's own personality (Zeigler-Hill, 2013). It is a person's global judgement of competency regarding one's self-worth (Cvencek, Greenwald & Meltzoff, 2016). Self-esteem can influence life in myriad ways, from academic (Feroz, 2018; Jirdehi, Asgari, Tabari & Leyli, 2018). Positive self-esteem could be in itself, sufficient motivation to try out difficult academic tasks. When students do not have such motivation, interest in learning may continue to wane. Interest is the giving of attention to some person, activity, situation or object (Renninger, 2003). Academic interest is known to be affected by a number of factors such as teaching method, students' attitude, skills and abilities. Studies show that interest affects achievement directly and indirectly (Kpolovie, Joe & Okoto, 2014; Olaf, Jurgen & Kai, 2001).

The understanding into the interaction of these variables to predict achievement in chemistry can be informed by research findings, learning theories and principles of temporal order. One however, needs to build a path model involving the variables to be able to not only determine the nature of interaction but also to validate the most meaningful and significant paths through the variables may predict achievement in chemistry.

Purpose of the Study

The purpose of the study was to conduct a path-analytic study of factors affecting academic achievement of tertiary education students in chemistry. Specifically, the study:

1. Examine the most meaningful causal model involving the selected factors for the prediction of academic achievement of students in chemistry.
2. Find out the relative contributions of each of the selected factors to the prediction of academic achievement in chemistry.
3. Determine the direct and the indirect effects of the independent variables on the academic achievement of students in chemistry that are predicted by the causal model.
4. Determine whether the model fits the data.

Research Questions

1. What is the most meaningful causal model for the prediction of academic achievement of students in chemistry?
2. What are the contributions of each of the selected factor to the prediction of academic achievement in chemistry?
3. What are the direct and the indirect effects of the independent variables on the academic achievement of students in chemistry?

Hypotheses

The hypothesized causal model was formulated based on the principles for generating a hypothesized causal model namely: temporal order, research findings, theories of learning and opinion or position of researchers and authors.

$$X_1 = P_{15}X_5 + \varepsilon_1$$

$$X_2 = P_{21}X_1 + \varepsilon_2$$

$$X_3 = P_{32}X_2 + P_{38}X_8 + \varepsilon_3$$

$$X_4 = P_{41}X_1 + P_{42}X_2 + P_{45}X_5 + P_{46}X_6 + P_{47}X_7 + P_{49}X_9 + \varepsilon_4$$

$$X_5 = P_{53}X_3 + P_{57}X_7 + \varepsilon_5$$

$$X_6 = P_{62}X_2 + \varepsilon_6$$

$$X_9 = P_{92}X_2 + \varepsilon_9$$

$$X_{10} = P_{103}X_3 + P_{108}X_8 + \varepsilon_{10}$$

$$X_{11} = P_{111}X_1 + P_{112}X_2 + P_{113}X_3 + P_{114}X_4 + P_{115}X_5 + P_{116}X_6 + P_{117}X_7 + P_{118}X_8 + P_{119}X_9 + P_{1110}X_{10} + \varepsilon_{11}$$

The resultant structural equations from the effects of the ten explanatory variables ($X_1 \dots X_{10}$) and their prediction of the criterion variable (X_{11}) is given in the equation:

$$X_{11} = \beta_1 X_1, \beta_2 X_2 \dots \dots \dots \beta_{10} X_{10}$$

Where;

X_{11} = Achievement in chemistry

X_1, X_2, \dots, X_{10} = Predictor (explanatory, independent) variables

$\beta_1, \beta_2 \dots \dots \dots \beta_{10}$ = Associated Beta Weight (Path Coefficients)

Nine structural equations resulted from all the hypothetical linkages as shown the input path diagram of the causal model of the eleven-variable system in Figure 1 below. Thus, the resultant equation above implied that academic achievement was predicted by all the ten explanatory variables through the path shown in the path model in Figure 1.

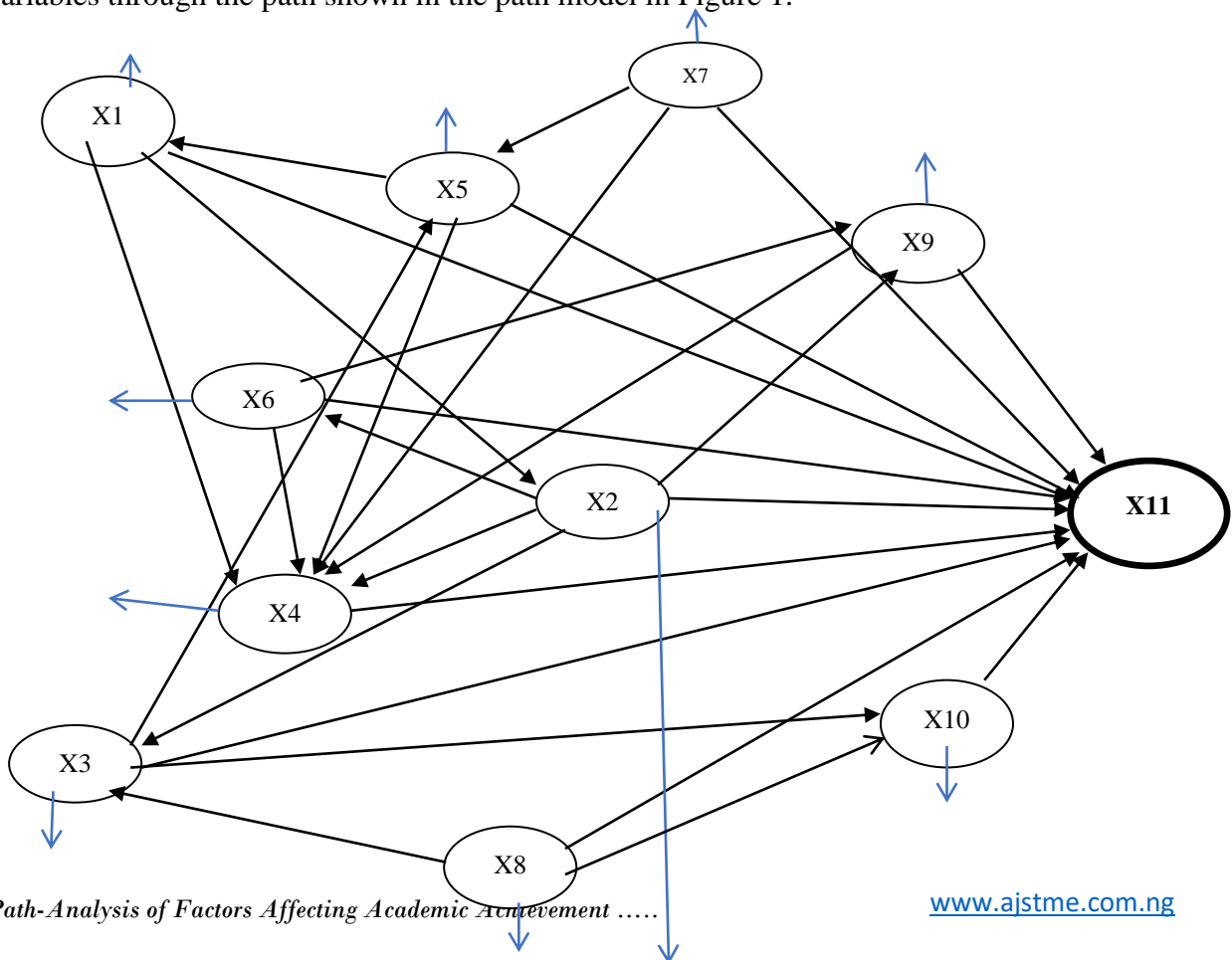


Figure 1: Hypothesized Diagram of Causal Model of an Eleven Variable system

The proposed equation of prediction therefore was:

Chemistry Achievement (CA)

$$= a + b_1TA_1 + b_2MT_2 + b_3SE_3 + b_4SH_4 + b_5AT_5 + b_6AR_6 + b_7IT_7 + b_8EI_8 + b_9SR_9 + b_{10}ST_{10}$$

Where

b_{1-10} = regression weights of the relative contributions of the predictor variables.

TA(X_1) = Test anxiety, MT(X_2) = Motivation, SE(X_3) = Self-efficacy, SH(X_4) = Study habit, AT(X_5) = Attitude AR(X_6) = Academic resilience, IT(X_7) = Interest, EI(X_8) = Emotional Intelligence, SR(X_9) = Self-regulated learning skills, ST(X_{10}) = Self-esteem.

It was therefore hypothesized as follows:

Hypothesis 1: The trimmed model fits the data as well as the just identified models.

Method

The design of the study was correlational survey and adopted a quantitative methodology with a confirmatory research background. The area of the study is Delta State. The population of the study was 1, 274 two hundred level chemistry education students. 200 chemistry education students in 200 level were sampled based on the expectation of using path analysis. This is because path analysis requires large sample size with consideration to the complexity of the model in terms of the ratio of the number of cases to the number of free parameter. It has been established by different authors that the best practice is to select sample with the ratio of 20:1. The study therefore, choose a ratio of 20:1. Thus, the sample size for the study was 200 chemistry students given that there are 10 free parameters. The sampling of the 200 students was purposive. The reason behind their selection was because they were running degree programs, are in final year and have results in environmental chemistry and organic chemistry courses for first and second semester respectively.

The instruments for the study data collection are: Chemistry Test Anxiety Questionnaire (CTAQ) adapted from the Mathematics Test Anxiety Scale developed by Chukwu (2014), Academic Motivation Scale (AMS) adapted from Njiru (2003), Chemistry Self-efficacy Scale (SES) adapted from the Webb-Williams (2006) self-efficacy scale, Study Habit Scale (SHS) adopted from Gordon (2002), Chemistry Attitude Scale (CAS) adapted from Myra's (2006), Academic Resilience Scale (ARS), Chemistry Interest Scale (CIS), Emotional Intelligence Questionnaire (EIQ) adapted from Mayer, Salovey, and Caruso (2004), Self-regulated Learning Skills Questionnaire (CSRLSQ) adapted from Maruff (2010) and Self-esteem Scale (SES) adopted from the Rosenberg (1965) self-esteem scale as re-validated Okwaraji, Nduanya, Obiechina, Onyebueke and Okorie (2018). The instruments were validated by experts from Nnamdi Azikiwe University, Awka. The coefficients of internal consistency of the instruments which was established using Cronbach's Alpha are: .72 for CTAQ, .67 for AMS, .81 for CSES, .62 for SHS, .91 for CAS, .78 for ARS, .72 for CIS, .77 for EIQ, .71 for CSRLSQ, and .70 for SETS.

The instruments were administered via google form, an online survey development cloud-based software which function as a service application, providing free, customizable surveys, as well as a suite of freeback-end programs that include data analysis, sample selection, bias elimination and data representation tools. Data relating to the research questions and hypotheses were

analyzed using confirmatory causal modeling involving multivariate analytical techniques of multiple regression (zero-order, backward or stepwise elimination procedure) and path analysis.

The multivariate technique was chosen because it enabled the researcher to establish how each student-factor interacts with each other and the dependent variable, thus, enabling the researcher to study the pattern of causation among the variables. Zero order and backward or stepwise elimination regressions were used to determine the joint and relative contributions (path coefficients or beta weights) of the predictor variables (test anxiety, motivation, self-efficacy, study habit, attitude, academic resilience, interest, emotional intelligence, self-regulated learning skills, self-esteem). To eliminate the multi-collinearity which is the co-variation among predictor variables in predicting the achievement in chemistry, causal linkage (effect) whether direct or indirect was established using path analysis technique. The researcher through the use of path analysis selected those variables that are meaningful and significant predictors (cause or effect) and isolated the separate contributions of the effects made by each causal variable. The questions and the analysis used in answering them are as follows:

Research Question 1: To answer research question three, the hypothesized model was sketched using IBM SPSS AMOS software, with the coded data uploaded from SPSS. The model (just-identified) was reproduced to show the path coefficients for each path using the unstandardized and standardized beta coefficients. To trim the paths in the model, path and path coefficient were considered meaningful if the path coefficient was less than 0.5 and paths are considered significant if the P value was less than 0.05. A table of meaningfulness and significance of paths was produced using the above decision. Using the table, the just-identified model was reproduced to show the most meaningful and significant paths (in bold arrows).

Research Question 2: The coefficients SPSS output table from the same multiple regression analysis of academic in chemistry on the ten students-related variables was analyzed to answer research question 2 (see Appendix N, p. 200). The standardized beta coefficients which are the path coefficient was used to indicate the relative contribution of each of the ten selected variables and the ranks showing the highest to the least contributor.

Research Question 3: The significant paths in the over-identified model were decomposed to into a table showing the direct and indirect pathways to answer research 4.

Hypothesis 1: To test the model fit of the study, use chi-square ($CMIN/ \chi^2$) to determine the values of the discrepancy between the two models (saturated and trimmed) with a Pvalue for testing the null hypothesis that the model fits perfectly. The also researchers used the Bentler's (1990) Comparative Fit Index (CFI) which according to Rebecca & Paul (2006) is an example of incremental fit index. Rebecca & Paul further noted that CFI compares the improvement of the fit of the researchers' model over a more restricted model, called the independence or null model, which specifies no relationship among variables. CFI ranges from 0 to 1.0 with values closer to 1.0 indicating better fit. Root Mean Square Error of Approximation (RMSEA) of 0.05 or less was also used to indicate closeness of the trimmed model or its approximation of the saturated model.

Results

Research Questions 1: What is the most meaningful causal model involving the selected factors for the prediction of academic achievement of students in chemistry?

The hypothesized model shown in Figure 1 was reproduced as Figure 2 with the path coefficient and the zero-order correlation coefficients (standardized beta coefficients).

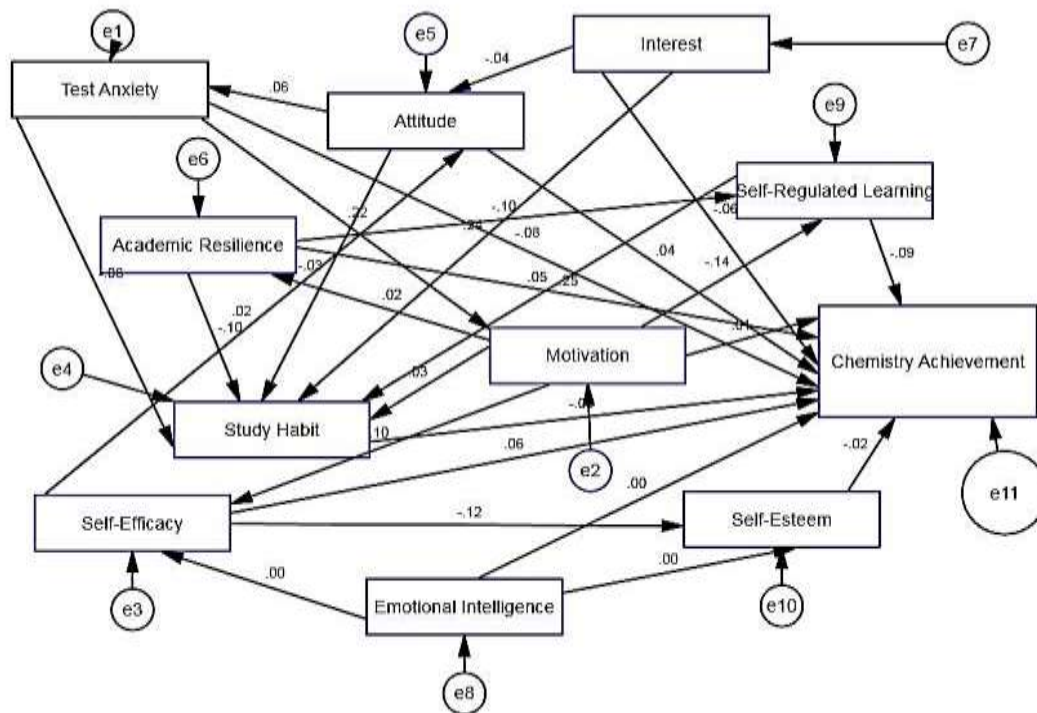


Figure 2: Just-Identified (Full, Saturated) Path Model of an Eleven Variable system showing Path Weights

To trim the paths in the model, path and path coefficient are considered meaningful if path coefficient is less than 0.5 and paths are considered significant if the P value is less than 0.05.

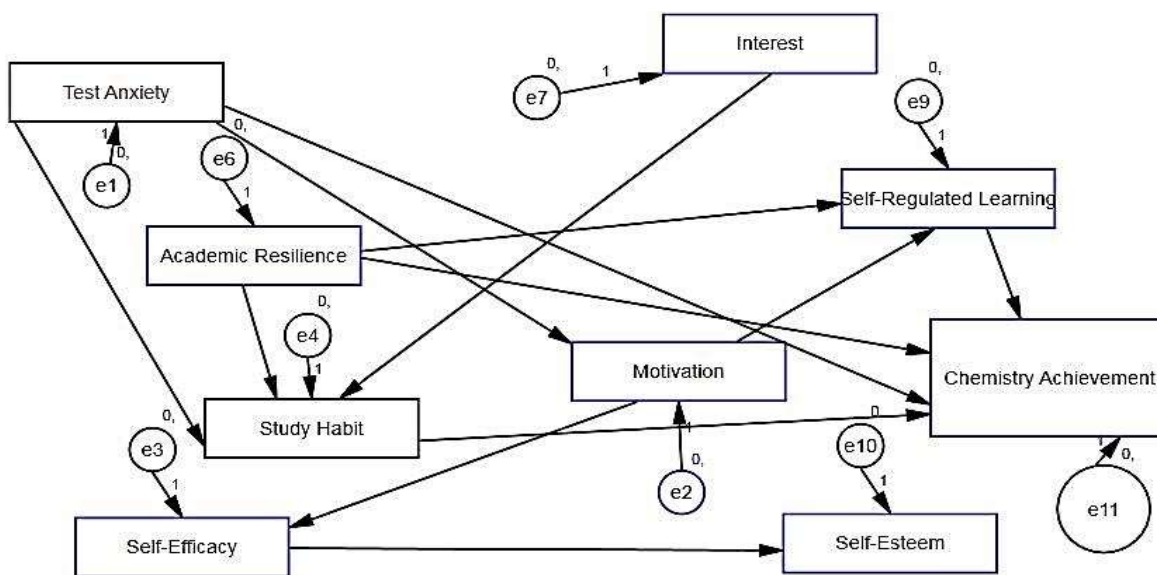


Figure 3: Over-Identified (Trimmed) Path Model of an Eleven Variable System showing Research Questions 2: What are the contributions of each of the students-factors (test anxiety, motivation, self-efficacy, study-habit, attitude, academic resilience, emotional intelligence, self-

regulated learning, self-esteem and interest) to the prediction of academic achievement in chemistry?

Table 1: Relative Contribution of the Ten Selected Students-Related Factors to Achievement in Chemistry

Variables	Unstandardized Coefficients		Standardized Coefficients		Rank	Sig.
	B	Std. Error	Beta	t		
(Constant)	77.572	25.813		3.005		.003
TA	-.257	.240	-.078	-1.070	3 rd	.017
MT	.006	.065	.006	.086	9 th	.931
SE	.051	.065	.056	.790	5 th	.431
SH	-.034	.052	-.048	-.654	6 th	.014
AT	.045	.076	.042	.593	7 th	.554
AR	.152	.044	.247	3.440	1 st	.001
IT	-.071	.089	-.059	-.802	4 th	.423
EI	-.002	.059	-.002	-.033	10 th	.974
SR	-.294	.221	-.095	-1.331	2 nd	.005
ST	-.093	.333	-.020	-.279	8 th	.781

a. Dependent Variable: Achievement *Sig. (P<0.05)

Table 1 shows the beta (β) weights of the paths (path coefficients) which give the estimates of the strength of the prediction by each selected factor. The entire ten factors contributed differently to the prediction of students' chemistry achievement. Specifically, academic resilience (AR), self-regulated learning skills (SR), test anxiety (TA) and study habit (SH) contributed significantly to the observed variance in the chemistry achievement of the students. The relative contribution of each variable showed that academic resilience made the highest contribution ($\beta = 3.440$; $p < 0.05$), followed by self-regulated learning skills ($\beta = -1.331$; $p < 0.05$), test anxiety ($\beta = -1.070$; $p < 0.05$) and then study habit ($\beta = -0.654$; $p < 0.05$).

Research Questions 3: What are the direct and the indirect effects of the independent variables on the academic achievement of students in chemistry?

Table 2 below shows that the model exerts direct effect on achievement in chemistry through four pathways and indirect effects through eight pathways. The four direct pathways are the direct prediction of achievement in chemistry by test anxiety, study habit, academic resilience and self-regulated learning skills.

Table 2: Direct and Indirect Pathways through which the Selected Factors caused Variations in Chemistry Achievement

Variations	Direct	Indirect
r111	P111	4: P ₁₁₉ P ₉₆ P ₆₄ P ₄₁ ; P ₁₁₉ P ₉₂ P ₂₁ ; P ₁₁₆ P ₆₄ P ₄₁ ; P ₁₁₄ P ₄₁
r211	-	1: P ₁₁₉ P ₉₂
r311	-	-
r411	P114	2: P ₁₁₉ P ₉₆ P ₆₄ ; P ₁₁₆ P ₆₄
r511	-	-
r611	P116	1: P ₁₁₉ P ₉₆
r711	-	-
r811	-	-

r911	P119	-
r1011	-	-
Total	4	8

The eight indirect pathways are the indirect causation/prediction of achievement in chemistry and it includes prediction of achievement in chemistry by:

- i. test anxiety through study-habit-academic resilience-self-regulated learning pathway
- ii. test anxiety through motivation-self-regulated learning pathway
- iii. test anxiety through study-habit-academic resilience pathway
- iv. test anxiety through study-habit pathway
- v. motivation through self-regulated learning pathway
- vi. study-habit through academic resilience-self-regulated learning pathways
- vii. study habit through academic resilience pathway
- viii. academic resilience through self-regulated learning pathway.

Hypothesis 1: The trimmed model fits the data as well as the just identified models.

Table 3: Model fit summary

Model	N moments	N parameter	Chi-Square (χ^2)	χ^2 Df	χ^2 Pvalues	CFI	RMSEA
Just-identified (Saturated)	77	77	0.000	0	-	1.000	-
Over-identified (trimmed)	77	49	7.952	28	0.064	0.948	0.025

Table 3 shows that the trimmed model has a low discrepancy from the just-identified model with a Pvalue of 0.064 which is greater than 0.05. Therefore, we do not reject the null hypothesis. Thus, the trimmed model fits the data as well as the just identified models. The CFI is above 0.9 indicating that the trimmed model was a good fit for the data. The RMSEA value of 0.025 was less than 0.05 also indicating that the rimmed model was a good approximation of the saturated model.

Discussion

The finding of the study showed that the ten predictor variables test anxiety (TA), motivation (MT), self-efficacy, study-habit, attitude, academic resilience, interest, emotional intelligence and self-esteem have a positive joint multiple correlation with achievement in chemistry and together they accounted for 9.3% of the total variance in achievement. This finding of the study shows the importance of the selected variables in prediction students' achievement in chemistry. The positive multiple correlations between the predictor and criterion variables shows that all the variables contribute to achievement in chemistry. The finding of the study can be explained from the very fact that the explanatory variables individually have certain relationship with achievement. However, some of the explanatory variables have higher predictive powers than others. Test anxiety which can with be facilitating or debilitating is known to either improve or mar achievement. When a student has heightened facilitating test anxiety, there is the likelihood that such students' anxiety is going to boost achievement in the test. Facilitating test anxiety improves cognitive process and becomes a triggering factor that activates other factors that have bearing with high achievement such as good study-habit and academic resilience among others. When facilitating test anxiety is low, there is also the likelihood that achievement could be poor. The idea is that the presence of low facilitating test anxiety may invariable be indicative of high

debilitating test anxiety while the presence of low debilitating test anxiety may be indicative of high facilitating test anxiety. To improve chemistry achievement therefore, a student is expected to have a low debilitating test anxiety level accompanied by a high facilitating test anxiety level. The presence of low debilitating test anxiety and high facilitating test anxiety may on other hand incite the students to study harder in order to improve achievement.

A good study habit implies a well-planned and deliberate pattern of study which has become consistent in the study life of a student. Thus, when a good study habit is formed, the student employs a sort of self-regulatory study skills in order to achieve the purpose of study and improve achievement. Chemistry as a science subject is practically oriented. Students who could manage their time both in the library and laboratory, set objectives and start studying on time for examinations and test, seek help from peers in the process of understanding a concept may improve on their chemistry achievement. Such good study habits are a function of high self-regulatory learning skills. Students who develop high skills of self-regulated learning often constitute those who have become academically resilient.

Resilient students are able to deal with academic drawbacks, challenges and academic pressures. They are able to regulate emotions and sustain just the positive motivation to continue to try to improve achievement despite academic adversities. It is the determination in academically resilient chemistry students that drives them to develop good study habits and self-regulatory skills as well as maintain high facilitating high test anxiety. A network of these factors among other interacts to keep such chemistry student solution focused. Resilience sustains the driving force for learning to the objective to be achieved is truly achieved.

The study showed that in their ranks, academic resilience relatively contributed most significantly to achievement in chemistry, followed by self-regulated learning skills, test anxiety and then study habit. These four variables have been shown in some empirical studies to be significantly factors in achievement. The findings of the study are therefore in line with the findings of Fayegh et al. (2010), Udeani (2012), Ali and Mohsin (2013), Chukwu (2014), Bakari and Aisha (2017) and Eman et al. (2016) that test anxiety is significantly related to achievement. The findings of the study lend credence to the findings of Lawrence (2014), Siah and Maiyo (2015), Tranhen, et al., Hayede, et al. (2017) and Silverrajo and Hassan (2018) that study habit is positively and significantly correlated with achievement. The findings of Novotny and Kremenkova (2016), Mwangi et al. (2018) and Majid (2018) that academic resilience have significantly relationship with achievement also supports the findings of the study. The finding of the study that self-regulated learning is a significant factor in achievement is supported by the findings of Khaled, Riyad and Omar (2017), Sara, Mohamad, and Hamid (2018) but contradicted by the findings of Damianus and Theogenia (2018) and Madihie and Mos (2018).

The findings of the study further reveal that the reproduced path model for predicting achievement in chemistry fit the data significantly. The most meaningful pathways however, are those that have interaction with academic resilience, self-regulated learning skills, test anxiety and study habit. The findings of the study support that finding of Saddler and William (1993) whose path model for predicting achievement revealed that study habit interacted with other variables in the model while predicting achievement directly. The findings of the study also support that of Asanee (2013) whose model showed that self-regulated learning and achievement have a common antecedent.

Conclusion

It can be concluded that all the 10 selected variables predicted the academic in chemistry both directly and indirectly and also through spurious paths and latent relationships. Some of the variables were however, more important than others in determining achievement in chemistry. Academic resilience self-regulated learning skills, test anxiety and study habit and all their pathways are very key in the achievement of chemistry students.

Recommendation

1. Diagnostic analysis of students-related variables should be carried out at the point of admission and as the students' progress academically by student affair departments in colleges of education in order to find out the areas the students may need orientation, guidance or counseling.

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