Modeling Teacher Classroom Practices, Students' Study Habit and Mathematical Ability as Determinants of Achievement in Chemistry

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PMB 91, Garki, Abuja Abstract
Structural equation modelling was used to model teacher classroom practices, students study habit and mathematical ability as determinants of achievement in chemistry The design adopted was ex post facto. Six hundred and one senior secondary 11 students were randomly selected through balloting from forty-five senior secondary schools in the Federal Capital Territory (FCT). Stratified random sampling technique was used to select the schools from the six Area Councils of the FCT, Abuja. Forty-five chemistry teachers, who teach the sampled students were also involved as respondents. The data was collected using Teacher Classroom Practices Observation Schedule (r = O. 71); Chemistry Achievement Test (r=(). 78); Study Habit Inventory 81); Mathematics Ability Test (r=0. 73). Four research questions were raised. The data collected were analyzed using Structural Equation Modeling (SEM). The study findings showed that the estimates of the direct effects of study habit on achievement was negative; teacher classroom practices and students' mathematical ability were found to strongly predict learning achievement in chemistry. Based on the study findings, it was recommended, among other things, that Chemistry teachers should consider helping their students have good grasp of basic mathematical operation during chemistry lessons

Introduction

Since the recognition of science and technology as instruments of development, there have been intense and rigorous research in science education globally (Egbujuo, 2009; Kempa, 2002). The result is that a lot of data and information have been generated from which the practitioners of science education and other teachers can draw in order to make science teaching and learning more effective, meaningful and functional (Egbujuo, 2012). These suggestions notwithstanding, the effectiveness of science teaching and learning has been unimpressive owing to students' performance in internal and external examinations (Apata, 2007; Achimugu, 2016). Relative to their counterparts in other countries, Nigerian students' performance in science subjects has been disheartening (Orji & Sumbabi, 2013). According to the Egbujuo (2016), for more than a decade (2001 - 2016), the average pass at credit level (Al — C6) in chemistry is 49. 2%. Many factors could be contributing to this abnormality, among which is students' mathematics ability.

Studies have shown that achievement in chemistry is strongly related to students' mathematics ability and application skills.

Mathematical ability could be seen to be the product of both latent trait and consistent interaction with the social environment in terms of performance on a task or class of tasks within the context of a given environment. This implies that expertise in any task is predominantly mediated by acquired complex skills and physiological adaptations (Egbujuo, 2016). According to Gary and Videman (in Zarch & Kadivar, 2006), mathematical ability can be broadly classified into two subscales namely, conceptual ability and strategic ability. Conceptual ability is the combined and practical knowledge of mathematical ideas and concepts which enable learners to acquire new ideas through the connection of the ideas they had already known (Suh, 2007). Conceptual ability, therefore, reflects student's ability to recognize, identify principles and facts and apply them as required (NRC, 2001). It also encompasses such abilities as being able to use symbols and terms appropriately, relate and aggregate principles and concepts towards solving given problems in novel situations. Strategic ability on the other hand, is being able to formulate, represent and solve problems that are mathematical in nature (Suh, 2007).

It has been observed that science students, due to weak mathematical skills always struggle with calculations in chemistry topics like stoichiometry and equilibrium (Polancos, 2009; Coll, Ali & Bonato, 2006; Aje, 2005). Students' knowledge in chemistry is often assessed using mathematically related questions. Areas in chemistry that require some level of mathematical knowledge include stoichiometry, Avogadro's number, balancing equations, etc. Essentially, performance in these aspects of chemistry will require such mathematical skills like arithmetic; working correctly with parentheses; appropriate use of fractions; application of decimals; applications of the principles of exponential equations and logarithm, calculations involving percentages; drawing and finding interpretations to simple line graphs and solving expressions in ratios and proportions.

Many studies have been done to unravel the relationship between mathematical ability of learners and academic achievement in chemistry. A study by Aje (2005), indicated the existence of a strong relationship between students' achievement in chemistry and their mathematical ability. Similarly, Adesoji and Ibraheem (2009) have shown that students who possess high ability level in mathematics had better performance in chemical kinetics as compared to those of medium ability level who were found to be better than those of low ability levels. In a more comprehensive study, Adigwe (2011), through the examination of all components of stoichiometric calculation in the senior secondary chemistry curriculum, showed that students' mathematics capabilities influenced their achievements in chemical stoichiometry. Scott (2012) had shown that poor grasp of rudimentary mathematical tasks involving arithmetic, especially when combined with the concepts of ratio or fraction affects students' achievement in chemistry, negatively.

Another factor that affects students' achievement in chemistry is the teacher classroom practice. Teaching involves the constant and ever-changing interaction between the teacher, the students and the subject matter. Practice has been explained by Wenger, McDermott, and Snyder (2002) as ideas, tools, frameworks, language, styles, etc. that are shared by a community of practice. Teachers' classroom practices have been interpreted to mean the techniques that teachers' exhibit in the process of trying to make the learning environment conducive for all categories of students (Deku, Amponsah & Opoku, 2013). The daily classroom experiences that students have with their teachers and peers have been argued to be of great influence on how much they can learn (Saxe, 1991, Egbujuo 2016). This perspective is socio-constructivist to the extent that the classroom is considered as a community of practices in which teacher and students act and construct meanings on a social plane and then possibly on a personal plane.

From theories and findings of empirical studies, there are three main domains of practice in teaching that bring about positive outcomes in learning. The domains are instructional support, social/emotional support and organization / management support (Hamre & Pianta, 2007). Attending to these domains have been shown to help in understanding the impact of classroom experiences on the performance of learners (Pianta, Hamre, & Allen, 2012). Classroom climate, identified as one of the dimensions of social/emotional support, is the learning environment that involves the shared perceptions of both learners and their teachers (Sinclair & Fraser, 2002). Studies have shown that classroom climate positively influences learning outcomes in both cognitive and affective domains (Church, Elliot & Gable, 2001; Dorman, 2001 From the perspective of the social learning theory, Anderson, Hamilton & Hattie (2004), assert that the best predictor of someone's actions is a meaningful environment. According to Lipoff (2011), classrooms become effective when the atmosphere is task oriented and the social and emotional needs of the learners are met through the establishment of mutual respect and good rapport.

Classroom climate has positive and negative dimensions. Students in positive classrooms climate experience supportive interactions with their peers and the adults. They also will enjoy every time spent in the learning environment. To Nielsen in Chrisenduth (2006), in positive classroom climate, the atmosphere is conducive to teaching and learning and learners are given maximum opportunities to learn as expectations are for them to achieve. However, students in a negative classroom climate constantly encounter irritation, discomfort, and humiliation as they work and interact with their peers and the teachers (Pianta, Hamre & Allen, 2012).

Emotional support is also measured by the extent to which classroom activities and dealings are made to meet the expectations and interest of the teacher, as against learners' interest and expectations (Pianta, Hamre & Allen, 2012). This dimension is commonly referred to as discourse making. Many aspects of the learning in science are affected by classroom discourse (Smart & Marshall, 2012). The authors further argued that discourse extends beyond classroom talks. According to them, it entails the aggregate of the interaction between teacher, students, and the unique perspectives manifested in their verbal communications.

Other fundamental ingredients of teacher classroom practices are teacher lesson design and its presentation. The lesson design is usually a pre-determiner of teacher's actions and inactions in the actual classroom setting. Lesson planning has been described as the teachers' foremost decision-making process that precedes instruction in the classroom (Howard, 2009). It thus entails teachers' conscious efforts in coming up with an organized plan of activities that enhances the development of learners' cognitive structures. According to Panasuk, Stone and Todd (2002), planning meaningful experiences for the learners is fundamental to achieving productive and impactful teaching engagement. Evidently, when a lesson is meticulously organized and presented, it promotes students' grasping of the linkages amongst the main ideas and concepts of a subject matter. Thus, the lesson plan and its presentation are integral parts of teacher classroom practices (Hamre & Pianta, 2007; Deku, Amponsah & Opoku, 2013).

Numerous researchers equate teacher classroom practices to teacher's style of lesson presentation. Schwerdt and Wuppermann (2008) in a study to establish how teacher classroom practices relates with students' achievement point out that when teachers use more of lecture method lesson presentation, they produce students with higher test scores. Also, according to the authors, spending extra one percent on lecture method lesson delivery as a substitute to problem-solving is associated with improvement in students' test scores between 0.09 (9%) and 0.16 (16%), of a standard deviation in test scores.

Another factor found to be affecting students' performance in chemistry is study habit. Even though it appears that the relationship between study habit and educational attainment have been firmly established in many studies, the findings differ from each other. Rana and Kausar (2011) showed that, in spite the fact that students of White British descents possessed better study habits than the students of Pakistani descents, the academic performances of students of the two races were not significantly different. The study also showed that school attended, and country of origin interacted significantly with the students' study habits but not with their academic achievement.

In an attempt to ascertain the effect of study habit on students' achievement, Ossai (2012) carried out an evaluation of the study habits of senior secondary school students and found that a difference that is significant exists between the study habits of male and that of female students. The study further showed that the girls had better study habits in the areas of Time scheduling, Concentration, Listening, Notetaking and Reading. Oluwatimilehin and Owoyele (2012) in a study of 300 male and female JS students of ages between 12 and 16 years submitted that, among the various aspects of study habits examined, teacher consultation had the highest correlation with science (r — 0.21). This was followed by reading and notetaking with r=O .20. Homework and assignments had the lowest correlation with science (r = 0.04). In the overall, the authors observed that concentration contributed highest to science performance followed by written work. They also found that while study period procedures contributed lowest to academic performance in science, homework, assignments and time allocation negatively contributed to students' performance in science. In a small-scale study involving 26 undergraduate chemistry students, Kim & Li (2012) found that a weak relationship exists between how long (in hours) a student studies per week and test scores. They also found that students who relied primarily on lecture notes as their study source outperformed their peers. A significant positive relationship has been found to exists between study habit and secondary school students' academic attainment (Bashir & Mattoo, 2012; Singh, 2011). According to Non is and Hudson (2010), study time positively influences students' performance when they can concentrate. These studies show that study habit could predict the academic achievement of students but with the interplay of other variables like gender, age, etc.

The above paints a picture, as was stated by Rivkin, Hanusheck and Kain (2005), that there is yet to be an agreement on the exact teacher and student variables that influence learners' academic achievement. In the light of the foregoing, an imperative measure was a shift to an alternative research approach that avoids the focus on a particular teacher or student characteristics. Thus, a structural model that incorporates selected student and teacher factors and achievement in chemistry has become very essential. This would help to establish the extent to which these factors contribute to students' achievement in chemistry.

Research questions

Four research questions were answered. They are:

1. What is the nature of the factor loadings of each of the latent traits?
2. What relationship exists among the latent traits?
3. What are the estimates of direct effects of (a) Teacher Classroom Practices

(TCP) (b) students' Math Ability (MA) and (c) Students' Study Habit (SSH) on students' achievement in chemistry as measured by CAT?

4. Does the model fit the observed data? If the model does, what is the model fit statistics?

Method

An ex post facto research design was adopted since there was no manipulation of variables. The population of this study comprised all the 2018/2019 SSII chemistry students and their teachers from the 56 public senior secondary schools in the Federal Capital Territory (FCT). The schools were stratified by Area Council and 45 were randomly selected unevenly by balloting. Average of 13 students were randomly selected from each school making it a total of 601 students. A chemistry teacher who had taught the students for at least one term was selected in each of the schools. The essence of this condition for the selection of teachers was to ensure that the teacher variables measured in the study can be linked to the students' academic achievement in chemistry. This means a total of 45 chemistry teachers, male and female, participated in the study. This number constituted 38% of the total population of chemistry teachers in the FCT senior secondary schools (FCT Secondary Education Board).

Four instruments were used for data collection. These are the Mathematical Ability Test (MAT), Teacher Classroom Practices Observation Schedule (T CPOS). Students' Study Habit Inventory (SSHI) and the Chemistry Achievement Test (CAT). The Mathematics Ability Test (MAT) is a twenty-five (25) item fill-in type basic mathematics questions developed by the researcher. The 25 items were arrived at after validation and pilot testing of the initially generated 30 items. MAT is designed to measure students' mathematical ability. The questions covered the following mathematics areas: ratio, percentages, word problems, simple algebra, proportions and basic arithmetic. These areas of mathematics were chosen because they are the areas of mathematics that are commonly applied in solving chemistry problems at this level. In the development of the items, attention was paid to ensuring that questions were unambiguous, unbiased, unloaded, relevant, succinctly conceptualized and without vagueness. The students spent twenty-five minutes in attempting the questions. While each correct answer earned two marks, every wrong answer attracted zero. In all, the maximum number of marks obtainable by a student is 50, which is equivalent to 100%. The TCPOS is in two parts. Part A was designed to obtain information on the teachers' demographic data. Part B was a 29-item observation schedule that covered teacher classroom practices. It had 5 sections, A to D, comprising lesson design, lesson implementation, discourse and sensemaking in science class and, classroom culture. The rating scale had 4 points ranging from "never = l", "rarely = 2", "sometimes = 3", to "always = 4". There was also a rating guide attached to the instrument. The SSHI, which was adapted from Bakare 1977, composed of 45 questions with 8 sections covering homework and assignment, time allocation, reading and note taking, study period procedure, concentration, written work, examinations and teacher consultation. The original version of the SHI has five response grids of "almost never", "less than half of the time", "about half of the time", "more than of the time", "almost always". The five-response grid was modified to four with the following response options: "never", "sometimes", "most-times", "always". The modification was as a result of the difficulties encountered by the students in completing the questionnaire during the initial pilot testing. After the modification, the instrument was revalidated and the reliability re-established. CAT is a two-part researcher-designed instrument. Part A concentrated on students' demographic data and Part B contained 30 multiple choice questions covering areas of chemistry taught the students in SSI and first term of SS Il. Specifically, chemistry areas covered in CAT are particulate nature of matter, chemical equations and combinations, gas laws, separation techniques, periodic tables, mass volume relationships, carbon and its compounds, acids, bases and salts. Each question has four options, one correct answer and three distractors, from which the students selected the correct answers to the questions Students' scores in CAT were used as a measure of their achievement in

Table 1: Maximum Likelihood Parameter Estimates of the Model

Parameter	Standardized Estimate	Unstandardized	Std. Error	z
Factor Loadings				
CAT PNM	0.		0.038	13.63
CAT— CFE	0.38*		0.049	7.81
CAT —GW	0.		0.052	10.70
CAT —CAB			0.055	12.10
MA →ALG	0.22*		0.049	4.56
MA→ART			0.048	9.27
MA →RAT	0.61*		0.048	12.86
MA +WDP	0.56*		0.048	11.77
MA—PEC	0.44*		0.048	9.11
TCP —LD	0.85*		0.033	25.40
TCP—Ll			0.032	28.03
TCP—DAS	0.94*		0.031	30.28
TCP+CLC			0.034	23.45
SSH —HWA	0.02		0.048	0.05
SSH —TA	0.49*		0.046	10.86
SSH —RNT	-0.44*		0.046	957
SSH —SPP	0.58*		0.045	13.03
SSH —CON	0.58*		0.045	12.89
SSH →WW	-0.49*		0.046	10.71
SSH →EXA	0.57*		0.045	12.66
SSH →TC	-0.26*		0.047	5.49
SSH	-0.49*		0.046	10.71

SSH —EXA 0.045 12.66 SSH —TC 0047 5 49

chemistry. While reliability for MAT, CAT and SHI were obtained using Cronbach's coefficient Alpha, the interrater reliability for TCPOS was obtained by computing the product moment coefficient of the scores assigned by the observers. The reliability coefficients of 0.73, 0.78, 0.81 and
0.71 were obtained for MAT, CAT, SHI and TCPOS, respectively. =

The instruments were administered on the students for four weeks by the researcher with the assistance of the chemistry teachers. Structural equation modelling (SEM) was deployed in answering the research questions. Specifically, Linear Structural Relations Analysis (LISREL) version 8.80 was used for the SEM analysis.

Results

Research Question 1: What is the nature of the factor loadings of each of the latent traits? Data for answering research question I is presented in Table I ,

Keys: SSH — Student Study Habit, HWA Homework and Assignment, TA = Time Allocation, RNT= Reading and Note Taking, SPP = Study
Period Procedure, CON — Concentration, WW — Written Work, TC — Teacher Consultation, TCP — Teacher Classroom Practices, LD = Lesson Design,

LI = Lesson Implementation, DAS = Discourse and Classroom Culture, ACHV — Achievement in Chemistry, PNM — Particulate Nature of Matter, CFE — Chemical Formulae and Equations, GMV — Gas Laws and Molar Volume Relationship, Sense-making in Chemistry Class, CLC= CAB — Carbon, Acids and Bases, M4 = Mathematical Ability, ALG = Algebra, ART = Arithmetic, R4T — Ratio, WDP = Word Problems, PEC =Percentages

Table 1 Continued.

Parameter	Standardized Estimate	Unstandardized	Std. Error	z
Measurement Error Variance				
ERROR PNM	0.51		0.044	11.59
ERROR CFE	0.85		0.052	16.32
ERROR CJMV	0.69		0.047	14.70
ERROR CAB	0.55			12.47
ERROR LD	0.28		0.020	14.50
ERROR Ll	0.19		0.016	12.31
ERROR DAS	0.11		0.013	8.69
ERROR ALG	0.95		0.056	16.87
ERROR ART	0.80		0.053	15.20
ERROR RAT	0.62		0.052	12.06
ERROR WDP	0.69		0.051	13.32
ERROR PEC	0.81		0.053	15.28
ERROR HWA	1.00		0.058	17.32
ERROR TA	0.76		0.050	15.10
ERROR RNT	0.81		0.051	15.68
ERROR SPP	0.66		0.048	13.77
ERROR CON	0.67		0.048	13.87
ERROR WW	0.76		0.050	15.17
ERROR EXA	0.68		0.048	14.03
ERROR TC	0.93		0.055	16.83

Table l presents results for answering research question l. It shows the standardized and unstandardized maximum likelihood estimate for all parameters of the four-factor (CAT, MA, SSH and TCP) structural equation model. From the Table, it is seen that most of the factor loadings (standardized coefficient) were statistically significant and ranged from being moderate to being high. This implies that these factors actually measured the latent variables. For example, PNM to CAT (0.70), CFE to CAT (0.38), GMV to CAT (0.55) and CAB to CAT (0.67) were good measures of Chemistry achievement (CAT). More importantly, the associated z-statistic in each case is greater than I .96. However, factor loadings of paths such as SSH to HWA (0.02, Z= 0.05) were very low and not significant.

Research Question 2: What is the nature of the relationship among the latent variables?

The question sought to find out the nature of the relationship among the latent variables (CAT, TCP, MAT, and SSH).

Table 2: Covariance Matrix of Latent Variables

	CAT	TCP	MAT	SSH
CAT	1.00			
TCP	0.51	1.00		
MAT	0.66	0.19	1.00	
SSH	-0 37	-0 07	0.08	

Table 2 presents the covariance matrix among the latent variables, while Fig. I shows the hypothesized model with all the path coefficients.

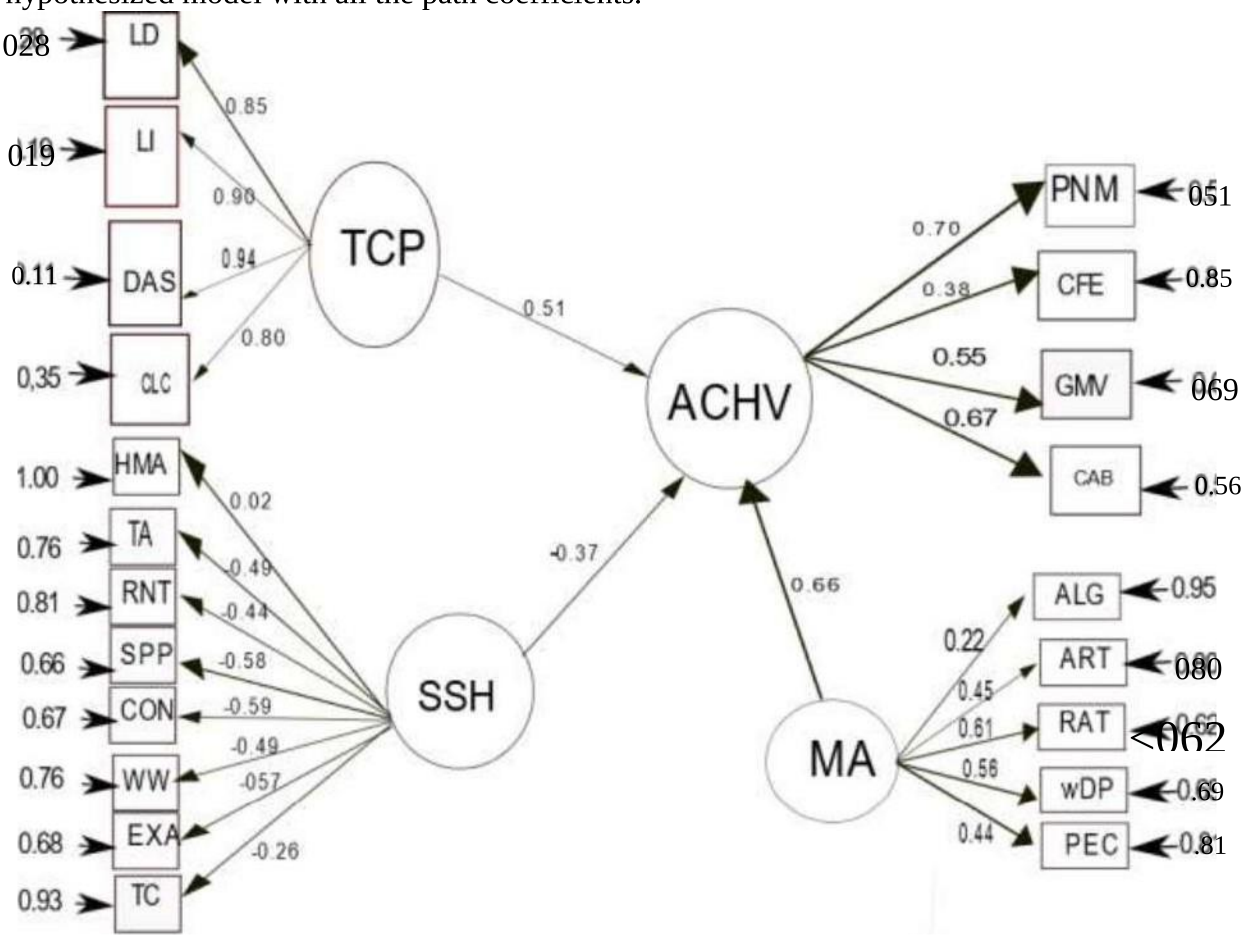

Fig. 1: A Parsimonious Structural Model with all the Path Coefficients

Research Question 3: What are the estimates of direct effects of (a) Teacher Classroom Practices (TCP) (b) Students' Math Ability (MA), and (c) Students' Study Habit (SSH) on students' achievement in chemistry as measured by CAT? From Fig. l, the direct effect of TCP on CAT is 0.51, which is positive, moderate and statistically significant at $p < 0.05$. This means that for every I full standard deviation increase in TCP, achievement in chemistry increases by 0.51 standard deviation units. Thus, the better the teacher classroom practices, the better will be the achievement of students in Chemistry. The TCP is a strong predictor of students' achievement in chemistry. Similarly, the direct effect of MA (O .66) on achievement in chemistry is high and positive. This entails that for every I full standard deviation increase in MA, achievement in chemistry increases by 0.66 standard deviation units. Thus, the better a student's mathematical ability becomes, the more likely would his/her achievement in chemistry improve. On the other hand, the direct effect of SSH (-0.37) on chemistry achievement is negative, though low and significant at $p < 0.05$. For SSH, the result implies that for every full standard deviation increase in SSH, achievement in chemistry decreases by 0.37 standard deviation units. SSH may therefore be having positive indirect effect on achievement in chemistry.

Research Question 4. Does the hypothesized model fit the observed data? If the model does, what is the model fit statistics?
This question was intended to find out if the hypothesized model fit the observed data and as well find out the model fit statistics. Fig. I presents the hypothesized model.

Table 3: Fit indices concerning the established model

Fit indexes	Calculated rate	Acceptable range
Chi-square (12)	1083.83, 269, p value = .00000	Between 2 and 5
Normed fit Index (NFI)	0.962	.95 for acceptance
Root Mean Square Error of Approximation (RMSEA)	0.07	Between .06 to .08 at 90% confidence interval
Comparative Fit Index (CFI)	0.93	Varies from O to I with larger value entailing good model fit. — 0.90 for acceptance
Parsimony Goodness of Fit Index (PGFI)	0.74	No threshold value has been recommended

See, Hu and Bentler, (1999); Kline, (2005); Steiger, (2007, Hoppe, Coughlam and Mullen (2008)

From the maximum likelihood estimates (see fig. l: The Model with all the Path Coefficients), the independence model Chi Square analysis shows that the variables are correlated, (269, N = 646) - 1083. 83, $p < 0.05$. The value of minimum fit function Chi Square is independence, (269, N = 646) = 1023.62, $p < 0.05$. The hypothesized model fit function Chi Square statistics shown in the result is significant. Since in a very good model fit situation, the model fit function Chi Square statistics should not be significant, other fit indices were examined. The examination indicated an acceptable overall model fit. Model fit statistics examined included: RMSEA = 0.07 with 90% confidence interval (0.06 — 0.075), CFI = .93, = .96, and = .74 (see Table 21 for explanation on model fit indices). These values, in general, show a good model fit (compare Steiger, 2007; Kline, 2005; Hu and Bentler, 1999).

Discussion of finding

The outcome of the SEM analysis revealed that study habit has a significant but negative direct relationship with academic achievement in chemistry. This is at variance with the findings of Bashir & Mattoo (2012) and Singh (2011) that a positive relationship exists between academic performance and study habit. Perhaps this disagreement in the findings ofthese studies could be as a result of the method of analysis adopted by the authors. It is also observed that the earlier studies only correlated study habit and achievement amidst the interplay of other variables, which could affect the outcome of their studies. This could also have contributed to the difference in the findings of the earlier studies and the present study. It is possible, therefore, that the positive effect of study habit is actually indirect. Further, the outcome of this study does not support the finding of the study by Shabbir and Rukhsana (2011) who found that in spite the fact that students of White British descents possessed better study habits than the students of Pakistani descents, the academic performances of students of the two races were not significantly different. This means that study habit does not relate with academic performance, either positively or negatively. The factor loadings of path from SSH to HWA (0.02) is very low and not significant. This implies homework and assignment (HWA) is not a good measure of students' study habit (SSH).

Regarding mathematical ability of students and achievement in chemistry, finding from the study reveals the existence of a positive and significant relationship between ability in mathematics and chemistry achievement. The direct effect of MA (0.66) on chemistry achievement (CAT) is positive, high and statistically significant at $p < 0.05$. This implies that for every I full standard deviation increase in MA, achievement in chemistry increases by 0.66 standard deviation units. Mathematical ability is a good predictor of students' chemistry achievement. This finding is consistent with the findings ofAdesoji & Ibraheem (2009), Adesoji & Oginni (2012), Adigwe (2011) andAje (2005) who reported of the existence of a significant positive relationship between achievement in mathematics test and performance in chemistry. This finding also gives credence to the finding of Polancos (2009) that the review of mathematics concepts before chemistry lessons had positive impact on the students' ability in chemistry problem solving.

From the study result, chemistry teachers' classroom practices relate positively and at a significant level with and students' achievement in chemistry. The direct effect of TCP on CAT is 0.51, which is positive, moderate and significant, statistically, at $p < 0.05$. This implies that for every I full standard deviation increase in TCP, achievement in chemistry increases by 0.51 standard deviation units, which is 51% of the standard deviation in the test scores. This entails that good teacher classroom practices enhances achievement of students in Chemistry. This finding replicates the findings by Wenglinsky (2002). According to Wenglinsky, teacher classroom practices are critical elements of students' learning and regardless of the students' preparation, teachers' teaching practices can either greatly enhance students' learning or constraint effectiveness in learning/teaching. This indicates that, according Schwerdt and Wuppermann (2008), teacher classroom practices, among other teacher related variables, is the most significant contributor to good students' test scores. One vital implication of this, with due consideration to the findings on the teacher classroom practices, is that there is urgent need to address the not-so-good classroom practices of most chemistry teachers in the FCT senior secondary schools, since it has great influence on students' achievement in chemistry.

One of the aims of this research was to determine the nature of the factor loadings of all the latent traits. Evidence from the study shows that most of the factor loadings (standardized coefficient) were statistically significant and ranged from being moderate to being high. This implies that these factors actually measured the latent variables. For example, PNM (Particulate Nature of Matter), CFE (Chemical Formulae and Equations), GMV (Gas laws and Molar Volume Relationships) and CAB (Carbon, Acids and Bases) were good measures of Chemistry achievement (CAT). This suggests that students' understanding of these components will, to a great extent, lead to success in chemistry learning at this level.

Conclusion and Recommendations

This study simultaneously estimated the direct effects of (a) Teacher Classroom Practices (TCP) (b) Students' Mathematical Ability (MA) and (c) Students' Study Habit (SSH) on students' achievement in chemistry. Whereas the estimate of the direct effect of SSH on academic achievement in chemistry was negative, that of teacher classroom practices and students' mathematical ability were positive and significant. This signifies that these two factors are strong predictors of learning achievement in chemistry. It could be established that learners taught by teachers with good classroom practices, irrespective of study habit of the learners, would be expected to record high academic achievements in chemistry. Furthermore, among the chemistry topics used to assess students' academic achievement, particulate nature of matter had the highest factor. Hence, students' good grasp of the chemistry concepts within the topic, at least at this level of education, would go a long way to helping them lay strong foundation in the learning of chemistry. It can, therefore, be concluded that the most important component of chemistry at this level of chemistry learning is particulate nature ofmatter, followed by acids and bases. On the basis of the findings of this research, it is recommended that:

1. Homework and assignment are key components of the school system. Most often students use their study periods in doing homework and assignments and then conclude that they have done some reading. Evidently from this study, homework and assignment are not important measures of study habit. The school guidance counsellors should, therefore, initiate orientation programmes aimed at helping students utilize their study periods for real studies in chemistry.
2. Particulate nature of matter had the highest factor loading among the topics used to assess students' academic achievement in chemistry. It is, therefore, imperative that chemistry teachers take note of this, and then organize teaching sessions and activities to enhance student's in-depth grasp of the concepts in particulate nature of matter and also in carbon, acids and bases, which had the second highest factor loading.
3. Students' mathematical ability was established to have positive direct effect on learners' achievement in chemistry. Special attention should be paid by schools towards enhancing the mathematical ability of students of chemistry. Chemistry teachers should also consider helping their students have good grasp of basic mathematical operation during chemistry lessons.

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