# DEVELOPING CAUSAL MODEL OF SOME PSYCHO-ACADEMIC AND SCHOOL VARIABLES FOR MATHEMATICS ACHIEVEMENT IN JUNIOR SECONDARY SCHOOLS IN AKWA IBOM STATE, NIGERIA

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## ABSTRACT

*This research work was designed to develop a causal model of some psycho-academic and school variables as they interact with students' performance in Mathematics. Three hypotheses were formulated to guide the study. This expost facto research employed stratified random sampling technique in selecting a total of 853 (407 males and 446 females) from 20 secondary schools in Akwa Ibom State. The study made use of two researcher developed and standardized instruments namely - 40-item Mathematics Achievement Test (MAT) and a Student Psycho-academic Information Questionnaire (SPAIQ). Data generated from these instruments were analyzed using the path analysis technique. Result of the findings generated a model with fourteen significant path ways which could be used to explain students' performance in Mathematics. The most meaningful causal model as well as direct and indirect effects of the psycho academic and school variables on students' performances in Mathematics were to be established. Furthermore, school location, school proprietorship, attitude towards Mathematics and study habit was found to have a direct and significant causal effect on Mathematics performance. It was recommended that a similar research should be carried out on the other compulsory subjects - Integrated Science and Social Studies at the Junior Secondary School level.*
*Keywords: Causal Model, psycho-academic and school variables, mathematics, achievement*

## INTRODUCTION

Path analysis was developed by Sewall Wright in 1918 as a method for studying the direct and indirect effects of variables hypothesized as causes of variables treated as effects (Kerlinger and Pedhazur, 1973). Path analysis is not a method for discovering causes, but a method applied to a causal model formulated by the researcher on the basis of knowledge and theoretical considerations. According to Pedhazur (1982) path analysis is useful in providing plausible explanations of observed correlations by constructing models of cause and effect relations among variables. Path analysis, as a model-building technique, uses multiple correlation and multiple regressions as its statistics. The result of path analysis is often pictorially represented in the form of the diagram. This is useful for displaying the pattern of causal relations among a set of variables. The primary rule of path analysis states that the

correlation between an independent and a dependent variable is the sum of the direct effect and all the indirect effects (Carey, 1998). Basically, the essence of path analytical procedures is to produce a more meaningful and parsimonious model from a chunk of hypothesized model. In order to arrive at this meaningful model, certain paths are trimmed off from the already hypothesized model. Path trimming according to Pedhazur (1982) is on the basis of statistical significance and the criteria of meaningfulness. Path trimming entails that certain paths with coefficient that are not statistically significant and/or are not meaningful in the explanation of the model be deleted from the diagram. Pedhazur (1982) suggests that paths with beta coefficient, which are less than 0.05, should be considered statistically insignificant and therefore be deleted. But beta coefficients up to 0.05 but not significant could be retained on the basis of meaningfulness. Once these paths are trimmed off the resultant model is the meaningful or parsimonious model, which is more useful for discussion.

Researches have been conducted into the effects, relationships or influence of different (student, related school related, psychological or psychosocial) variables individually on students' academic achievement. In recent years there have been an increasing awareness on the interactive nature of various variables in humans, thus the need to investigate into the composite and just not individual effects of these variables on the child's performance. This has necessitated a gradual shift away from single variable studies to studies to look into the combined effect of related variable. Hither to statistical tools like the students' t-test, correlation analysis, and chi-square were in common use; latter the use of ANOVA and multiple regression came into focus. Lately the shift has moved gradually towards the use of more sophisticated analytical tools like the path analysis, especially with the extensive use of the computer. Although the use of path analysis is relatively low there has been an increasing awareness on its advantages. Here is a review of a few studies that employed path analysis to investigate the effects of different variables on students' academic achievement.

A study by Sherry and Jessey (2005) employed path analysis to investigate the relationship between instructional technology and student achievement. The independent variables were motivation, metacognition, learning processes with students' achievement as the dependent variable. Results from the analysis showed that motivation on learning process significantly predicted performance of students. The researchers also observed a high and significant relationship between inquiry learning (a type of learning process) = 0.75 and metacognition between and application of skills (a type of learning process). Anagbogu (2005) in his research into a path analytic model for correlates of secondary school students performance in financial accounting in Southern Educational zone of Cross River State, Nigeria generated a 21-path hypothetical recursive model while attempting to uncover the effects of sex, availability of instructional materials, self

concept, causal attrition, motivation and attitude to subject on students' performance in financial accounting. The research used information from 390 students in 15 secondary schools from the study area; the 21-path model was eventually trimmed to a new parsimonious path model with 10 significant pathways. The analysis further indicated that sex, availability of instructional materials, self-concept, causal attrition, motivation and attitude significantly determined performance in financial accounting directly or indirectly.

An abstract from another study conducted by Chadha (2006) on causal antecedents of self-concept, locus of control and academic achievement, a path analysis recursive model was proposed to determine to what extent the personality variables account for the relationship between the background variables and academic achievement and the extent to which the relationships between the personality variables and academic achievement are accounted for by the background variables. Based on the data gathered from 307 12th grade students through the use of paper and pencil test to measure background and personality variables, which information on student's achievement was collected from the school files; results of the path analysis carried out on the data indicated that creativity, sex and quality of family relationships account for 12.8% and 19.2% of the variance for self-concept and locus of control respectively, while creativity, sex, quality of family relationships, self concept and locus of control accounted for 57.8% of the variance for academic achievement. It is worthy to note that from the studies reviewed there was an interplay of the different independent variables on the dependent variable therefore the excessive result from a case of a single variable effect was tampered by the effect of the other variables.

Path analysis comes in handy as an effective analytical tool in educational research endeavours due to the interactive nature of most personal, psychological, socio-economic, school, academic etc. variables involved in the study of students' behaviour and academic achievements. Simple correlation studies between single variables do not seem to give a complete or true picture, thus, the use of this comprehensive analytical tool has been found to be a better option as this gives a suggestive guide to the possible causes of the linkages. This research effort therefore, intends to design a possible causal model that could uncover the interactive effects of some psycho-academic and school variables on students' academic achievement with regard to their performance in Mathematics at the Junior Secondary School level through the use of path analytic technique. The main purpose of this study was to develop a causal model involving some psycho-academic and school variables on Junior Secondary 3 students' achievement in Mathematics. In specific terms, the study is designed to:
1.   Estimate the strengths of the causal paths of the nine variables in the 28 hypothesized path model involving the psycho-academic and school variables, and JS 3 students' performance in Mathematics.

2.      Construct the most meaningful causal model involving the nine variables of (study habit, test anxiety, attitude to schooling, attitude towards Mathematics and test of wisdom). The school variables are - school location, school type and school proprietorship) and JS 3 students' performances in Mathematics.
3.      Identify variables with significant direct effects on the JS 3 students' performances in Mathematics.

To guide the study  the following null hypotheses were formulated:

1.      The standardized path coefficients of the nine variables in the hypothesized path model involving the psycho-academic and school variables and JS 3 students' performance in Mathematics are not statistically significant.
2.      There is no significant, meaningful and parsimonious causal model involving the psycho-academic and school variables for JS 3 students' performance in Mathematics.
3.      There is no significant direct effect of psycho-academic and school variables on students' performance in Mathematics.

## METHODOLOGY

The research design adopted for this study was basically causal comparative. On the basis of the expost facto design the researcher constructed a hypothetical path model for JS 3 students' performances in Mathematics. The study made use of all the JS 3 students from both public and private secondary schools in Akwa Ibom State, with an approximate JS 3 student population of 29,000 for the 2005/2006 academic year. The researcher employed the stratified random sampling procedure in sampling out twenty schools out of which thirteen were public while seven were privately owned schools.  From the thirteen public schools seven were sampled from the urban community while the remaining five where in rural areas. For the eight privately owned schools four were from the urban area while three was located in the rural parts of the state. From each of these twenty schools, fifty students were randomly sampled to make up a study sample of one thousand respondents.

Only eight hundred and fifty three students (four hundred and seven males and four hundred and forty six females) completed and returned the questionnaire. Two instruments were employed by the researchers to gather relevant information for this study namely; Mathematics Achievement Test (MAT) and the Students' Psycho-academic Information Questionnaire (SPAIQ). To ascertain the respondents' academic performance in Mathematics, a 60-item test was constructed and used. The instrument developed by the researchers was based on the JSS 3 syllabus for the subject. Items included in the instrument were based on knowledge, comprehension and application levels of Blooms taxonomy of educational objectives. The content areas tested on were: number systems; factors and multiples; fractions and percentages and geometry. Others

include algebra; mensureation; proportion and ratio; variation and probability; everyday arithmetic; and statistics.

The Students' Psycho-Academic Information Questionnaire (SPAIQ) consisted of two parts. Part A was to enable the researcher elicit demographic information on the respondents, while Part B consisted of 10 items for each of the five (5) psycho-academic variables under study, The respondents expressed their level of agreement or otherwise to each statement based on a 4 point Likert type scale of Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD). The researcher constructed the items for each variable in the study. The items on the questionnaire were vetted and reviewed by Measurement and Evaluation experts, while Secondary school teachers who are currently teaching mathematics vetted the achievement tests items.

The original 60-item Mathematics achievement test was pre-tested using 100 JS3 students in four secondary schools within the study area. The result of the item analysis conducted guided the researcher on the selection of the final 40-item instrument, items with negative discrimination indices were discarded while those with low difficulty/low discrimination indices were restructured. The reliability coefficient of 0.92 for the mathematics achievement test was established using the split-half method. The reliability of the SPAIQ was calculated on the basis of the subsets in the instrument using the Cronbach alpha statistical procedure. The reliability coefficient for each subset is shown on Table 1.

**Table1:** Reliability results of the instruments

| Variables | No. of items | Mean | SD | Cronbach alpha |
|---|---|---|---|---|
| Test Anxiety | 10 | 17.15 | 5.03 | 0.72 |
| Test Wiseness | 10 | 29.92 | 2.74 | 0.59 |
| Study Habits | 10 | 33.46 | 0.68 | 0.87 |
| Attitude to Schooling | 10 | 32.61 | 5.08 | 0.91 |
| Attitude towards English | 10 | 31.60 | 4.67 | 0.77 |
| Attitude towards Mathematics | 10 | 32.14 | 4.60 | 0.82 |

Source: Survey 2010

The researcher with the assistance of the mathematics teacher in the sampled schools administered the instruments. These teachers were enlisted by the researcher as research assistance for the proper collection and collation of the relevant data from the respondents. Each instrument was administered within a day in each school so, data collection in each school lasted two days. The SPAIQ which had 10 items each for the following variables namely; test anxiety test wiseness, study habits, attitude to schooling, and attitude towards Mathematics, were scored 4, 3, 2 and 1 on a Likert type agreement scale Strongly Agreed (SA), Agreed (A) Disagree (D) and Strongly Disagree (SD). Scores for all negatively warded items were reversed and Strong Agree (SD) through to Strong Disagree will take on the rating of 1 to 4 respectively. The Mathematics achievement tests, correctly answered items had a score of 1 while incorrect items were scored 0.

For the path analytic aspect of the data processing, the variable used in the study were labeled as shown below:

| | | |
|---|---|---|
| $X_1$ | = | School Location |
| $X_2$ | = | School type |
| $X_3$ | = | School proprietorship |
| $X_4$ | = | Study habits |
| $X_5$ | = | Test anxiety |
| $X_6$ | = | Attitude to Schooling |
| $X_7$ | = | Attitude towards mathematics |
| $X_8$ | = | Test wiseness |
| $X_9$ | = | Performance in subject mathematics. |

The students involved in the researched were assigned numbers from 001-999 this was to aid in the proper tracking of individual scores for the different variables.

## RESULTS AND DISSCUSSION

The results of the study were presented according to the stated hypotheses;

**Hypothesis 1:** The standardized path coefficients of the variables in the hypothesized model and JS 3 students' performance in mathematics are not statistically significant.

**Table 2:** Paths, their coefficients and effects on Mathematics performance

| Paths | Path Coff. | | Nature of Path | Remarks |
|---|---|---|---|---|
| $P_{41}$ | -0.023 | ____ | NS | |
| $P_{42}$ | -0.027 | ____ | NS | |
| $P_{43}$ | 0.163 | Indirect | S | |
| $P_{51}$ | 0.128 | Indirect | S | |
| $P_{52}$ | -0.012 | ____ | NS | |
| $P_{53}$ | -0.066 | ____ | NS | |
| $P_{61}$ | -0.048 | ____ | NS | |
| $P_{62}$ | 0.036 | ____ | NS | |
| $P_{63}$ | 0.078 | Indirect | S | |
| $P_{64}$ | 0.288 | Indirect | S | |
| $P_{65}$ | -0.249 | Indirect | S | |
| $P_{71}$ | 0.031 | _____ | NS | |
| $P_{72}$ | 0.005 | _____ | NS | |
| $P_{73}$ | -0.011 | _____ | NS | |
| $P_{76}$ | 0.373 | Indirect | S | |
| $P_{81}$ | -0.056 | _____ | NS | |
| $P_{82}$ | 0.026 | _____ | NS | |
| $P_{83}$ | 0.039 | _____ | NS | |
| $P_{84}$ | 0.168 | Indirect | S | |
| $P_{85}$ | -0.041 | _____ | NS | |
| $P_{91}$ | -0.151 | Direct | S | |
| $P_{92}$ | 0.029 | _____ | NS | |
| $P_{93}$ | 0.535 | Direct | S | |
| $P_{94}$ | 0.061 | Direct | S | |
| $P_{95}$ | 0.027 | _____ | NS | |
| $P_{96}$ | 0.035 | _____ | NS | |
| $P_{97}$ | 0.090 | Direct | S | |
| $P_{98}$ | 0.023 | _____ | NS | |

Table 2 revealed that the beta weights for the hypothesized paths ranged between 0.011 for P73 and 0.535 for P93. Testing the significance of the path coefficient in the hypothesized recursive model at 0.05 alpha level of

significance, eleven (11) out of twenty-eight (28) paths hypothesized met the criteria for significance. On the strength of the analysis, it implies that the hypothesis that standardized path coefficients of the nine variables in the hypothesized path model involving the psycho-academic and school variables and JS 3 students' performance in Mathematics are not statistically significant is rejected for 11 out of the 28 possible pathways hypothesized.

**Hypothesis 2:** There is no significant, meaningful and parsimonious causal model involving the psycho-academic and school variables for JS 3 students' performance in Mathematics. To verify this hypothesis, the data gathered was analyzed to obtain original correlation coefficient of the variables in the study. More so, path coefficient for each hypothesized pathway in the recursive model was calculated.
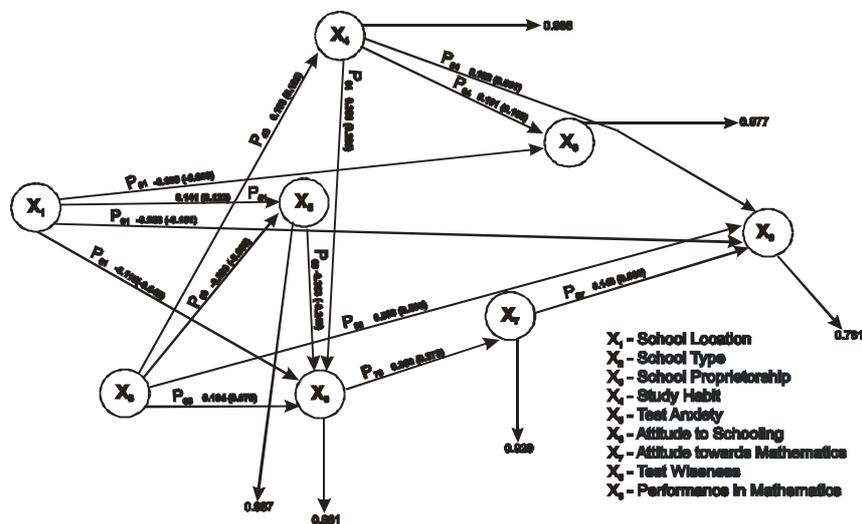


**Fig. 1:** A parsimonious causal model of eight variables on student's performance in Mathematics with original correlations beta weights.

The paths whose coefficients are significant at 0.05 level and an a few paths considered meaningful were retained while others were trimmed to produce a more parsimonious (over identified) model. Of the 28 hypothesized paths only 14 met the criteria of significance and meaningfulness. Fig 1 shows a more parsimonious causal model with the 14 surviving paths. On a closer inspection of Fig. 1 the numbers found on each pathway represent the original correlation coefficients while the numbers in bracket represent the beta weight of each pathway. The direction of the causal paths of the variables in the model, were the pathways which are significant and meaningful, as well as have a link with the dependent (criterion).

**Hypothesis 3:** The data presented in Tables 2 and 3 were used to verify the hypothesis that there is no significant direct effect of psycho-academic and school variables on students' performance on Mathematics.

**Table 3:** Variables with direct effects on Mathematics performance

| Variable | Beta Weight | Remarks |
|---|---|---|
| School location | -0.151 | S |
| School type | 0.029 | NS |
| School proprietorship | 0.535 | S |
| Study habit | 0.061 | S |
| Test anxiety | 0.027 | NS |
| Attitude to schooling | 0.035 | NS |
| Attitude toward Mathematics | 0.090 | S |
| Test wiseness | 0.023 | NS |

Source: Survey 2010

Table 2 shows the nature of the effect of each path on the criterion variable. Out of the 28 pathways outlined on Table 2, four pathways (P91, P93, P96, and P97) were found to have and significant effect on the dependent variable,. Table 3 shows that four out of the eight direct paths (criterion / independent) variables had a significant direct effect on Mathematics performance. These variables include; school location, school proprietorship, attitude to schooling and attitude towards Mathematics. It is worthy to note that school proprietorship has the most effective direct causal influence on students' performance in Mathematics. On the basis of this therefore, the null hypothesis of no significant direct effect of school and psycho-academic variables on students' performance in Mathematics was rejected for school location, school proprietorship, study habits and attitude towards Mathematics, while the null hypothesis is retained for school type, study habit, test anxiety and test wiseness.

On inspecting Table 3, school location, school proprietorship, study habits and attitude towards Mathematics are the variables that have direct significant causal effect on students' performance in Mathematics. School proprietorship recorded the highest beta weight of 0.535 to top the list. The direct effect of school proprietorship on performance supported by earlier study by Kim and Placier (2004) was enhanced by its significant correlation with study habits, attitude to schooling and test anxiety, as school proprietorship on study habits; school proprietorship on attitude to schooling; and school proprietorship on test anxiety were found to significantly predict performance.

Along with school location's significant effect of performance, as also recorded by studies conducted by Mosha (1988), results further showed that school location on test anxiety significantly predicted performance in Mathematics. The direct significant effect of study habits on Mathematics performance was affirmed by previous studies conducted by Idika (2004). This research has further uncovered that attitude towards Mathematics also had a direct effect on students' performance on the subject. This result was affirmed by an earlier work undertaken by Thompson (2001). It is worthy of note that school type had no direct or indirect effect on Mathematics performance.

## CONCLUSION AND RECOMMENDATIONS

The research findings indicated that a meaningful causal model with 14 pathways involving the nine variables can be used to explain students' performance in Mathematics. Four variables of school location, school proprietorship study habits and attitude towards Mathematics had direct significant causal effects on students' performance in the subject under study. Based on the findings of this study, the researcher recommends that the government, teachers, parents and all stakes holders in the educational sector should:

(a)     Put the necessary mechanism in place to: improve the teaching/learning conditions in public and rural schools to enable students in these schools compete favourable with their counterparts in private and urban schools.

(b)     Consciously work on their students' study habits and attitude towards the different school subjects particularly Mathematics as this will directly impact their performance in school.

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