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Personality Determinants of Achievement in Mathematics among Senior Secondary School Students in Akwa Ibom North-West Senatorial District, Nigeria

Udoukpong, Ubokobong Daniel*
Professor Umoinyang, Imo E.
Department of Science Education
Faculty of Education, Akwa Ibom State University
Ikot Akpaden, Mkpat Enin Local Government Area
**E-mail: ubokchrist@gmail.com*

ABSTRACT

This study constructs and tests a six (6) variable model (neuroticism, extroversion, openness, conscientiousness, agreeableness, and self-concept) in senior secondary schools as a basis to provide a causal explanation for achievement in Mathematics. It was an ex-post facto and causal-comparative research in the North West (Ikot Ekpene) Senatorial District of Akwa Ibom State, Nigeria. The population comprises all the public secondary school students in the Senatorial District. A simple random sampling technique was used to select 600 students from 10 secondary schools purposively selected from 10 local government areas. The personality factor scale and Mathematics achievement test were the instruments for data collection. The results indicated that the most meaningful causal model had 16 significant pathways. The pattern of the original correlation was consistent with Udoukpong's model of students' personality factors as determinants of achievement in senior secondary school Mathematics. Four (4) personality factors (self-concept, neuroticism, openness, and extroversion) directly or indirectly determine senior secondary school students' achievement in Mathematics. It therefore recommends the causal order in Udoukpong's model of students' personality factors to boost academic achievement in Mathematics.

Keywords: *Personality factors, academic achievement, and Mathematics.*

INTRODUCTION

Education is a vital tool for change and economic development of a nation. An educated population is essential to a nation's prosperity (Ogbonnaya, 2020). If people are enlightened, there is greater productive efficiency with rapid growth and development. Countries compete on literacy rates, which lead to higher economic growth and development. A nation is affected by education in one way or another, especially in Science, Technology, Engineering, and Mathematics (Sulai M. and Sulai E., 2020).

Science, Technology, Engineering, and Mathematics (STEM) build and maintain the development of a nation (Randall, 2019). STEM is vital for countries seeking to reduce their poverty levels to adopt reports and recommendations of new scientific research and technology. By so doing, they can improve their economy, health care system, infrastructure, and lots more.

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In Nigeria, one of the specific goals of the National Policy on Education with respect to STEM is to provide technical knowledge and skills necessary for the individual, commercial and economic development. Also, to train people who can apply scientific knowledge to solve environmental problems for the convenience of man (FGN, 2013), but Nigeria is yet to attain these goals. STEM education creates critical thinkers, increases science literacy, and enables the next generation of innovators. These are anchored on the knowledge of Mathematics (Olugbenga, 2016), as Mathematics is the core of science, technology, and engineering.

The development of a nation has been linked to its scientific and technological development. According to Olugbenga (2016), Mathematics is the mother of science and all other subjects; a nation that wants to experience economic growth must have a commitment to science and Mathematics. It implies that science and mathematics play a significant role in economic, technical, political, and environmental development. It has permeated all facets of human life. Mathematics is an integral part of the Nigerian education curriculum (FRN, 2013), due to its significance in national development, the Federal Government of Nigeria in the National Policy on Education made the subject compulsory from primary through secondary schools, and students are required to pass it as part of the minimum requirement for further education in science and science-related disciplines. It is because of its importance and the dynamic role in modern-day society as affirmed by Bassey (2010) and Charles – Ogan (2014). Its inclusion as a pre-requisite for admission into science and technology-based courses in tertiary institutions may be because of the recognition of the indispensable role it plays in the advancement of science and technology of any nation (Iyekekpolor and Buleis, 2009).

Mathematics as a subject plays the role of a precursor and harbinger of the much-needed technological and natural development (Omirin and Oladesu, 2010). It is highly beneficial to an individual as it creates a path to financial security, economic mobility, personal growth, professional development, leadership opportunities, and the promise of a brighter future (Jackson, 2015). Mathematics is the key to all other subjects. According to Ndungo (2018), there is no work one can do without applying Mathematics; but many students fail it and yet, pass other subjects. Carl (1796), a famous Mathematician, also known as the Prince of Mathematics was the first to refer to Mathematics as the queen of all sciences. Olugbenga (2016) also stated that Mathematics is the mother of all subjects. He argued that Mathematics is the foundation of other subjects of study, which has its tentacles at the beginning and the conclusion of these subjects. Afe (2012) and Nyaumwe (2013) stated that Mathematics is the bedrock and an indispensable tool for the scientific and economic advancement of a person and a nation. Thus, Mathematics plays a crucial role in human life.

Nigeria as a nation and Akwa Ibom State, in particular, have made efforts to encourage the study of Science and Mathematics. These include organizing science quiz competitions for students, STEM competitions, participation in the international Olympiads competition, and training and retraining of Mathematics teachers anchored by the National Mathematics Centre. Despite these efforts, students' achievement in Mathematics at Senior School Certificate Examination (SSCE) has not been encouraging. Students' achievements in Mathematics for five (5) years are presented in Table 1.

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Table 1: West African Examination Council Result for Mathematics (2016 - 2020)

Year	Number Sat	Number Pass (Credit and above)	% Pass (Credit and above)
2016	1 543 974	950 730	61.6
2017	1 558 452	1 108 657	71.1
2018	1 571 536	1 058 054	67.3
2019	1 590 173	1 020 519	64.2
2020	1 538 445	1 003 668	65.2

(Source: National Bureau of Statistics and https://www.waecnigeria.org)

The achievement of students at external examinations is not steadily increasing or decreasing. Apart from 2017, there has not been an excellent achievement despite the importance of the subject. In 2017, a 71.1% pass was recorded but dropped by 3.8% in 2018 and in 2019 by 6.9%. Though an improvement was recorded in 2020 by only 1%, it is worrisome that students' achievement in Mathematics over the years is fluctuating. Hence, a need to investigate how to maintain an excellent percentage passes in the subject. To improve academic achievement, Nigeria has created the National Mathematics Centre to train and re-train teachers, organise seminars and workshops, and provide Mathematics kits and models for better understanding of the subjects by the students. Despite the efforts by government and individuals to improve academic achievement in Mathematics, many students still find it difficult to pass the subject. However, some factors are responsible for the students' cognitive learning outcomes in Mathematics. Among these factors are the attitude of the learners towards the subject, economic conditions, inappropriate instructional techniques, low motivation of teachers, type of school, instructional materials, study habits, teachers' qualification, lack of teaching experience, lack of teachers' continuous professional development, lack of access to new technologies, and personality factors (Afe, 2012; Nyaumwe, 2013; Umoinyang, 1999; Umoinyang and Inyang, 2021).

Due to the global awareness of the importance of mathematical knowledge on the one hand and the concern expressed for many years at various levels of education about underachievement in Mathematics on the other hand (Eng, Hedestam, and Mclnerney 2010), the achievement of students in Mathematics from primary school to higher education is still a topic of concern, especially at the senior secondary school level. It has attracted many types of research in Nigeria. Despite their scope and perhaps depth, they only examined the influence of one or a combination of some personality factors (neuroticism, extroversion, openness, conscientiousness, agreeableness, and self-concept). However, these studies did not provide empirical evidence of sequence, direction, and strength of causal interaction among these variables and the criterion (Mathematics achievement) when several of these predictor variables are together. It thus seems that explaining these interactions in terms of causal linkages (multivariate studies) is under-researched. Therefore, neuroticism, extroversion, openness, conscientiousness, agreeableness, and self-concept (NEOCAS) are considered since a better understanding of causal influences of personality variables on Mathematics achievement would be of considerable help in developing a theory in teaching Mathematics (Umoinyang, 1999) and improve achievement in the subject. The study constructed and

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tested a six (6) variable model (neuroticism, extroversion, openness, conscientiousness, agreeableness, and self-concept) in Senior Secondary School Mathematics as a basis for providing a causal explanation for achievement. The issue is; can these personality factors determine senior secondary school students' achievement in Mathematics directly and indirectly?

The purpose of the study is to establish the extent to which personality factors determine senior secondary school students' achievement in Mathematics. Specifically, it develops a causal model involving neuroticism, extroversion, openness, conscientiousness, agreeableness, and self-concept for achievement in senior secondary school Mathematics. What are the most meaningful causal models involving neuroticism, extroversion, openness, conscientiousness, agreeableness, and self-concept for achievement in senior secondary school Mathematics?

Hypothesized Path Model

The model in Figure 1 was proposed to guide this study:

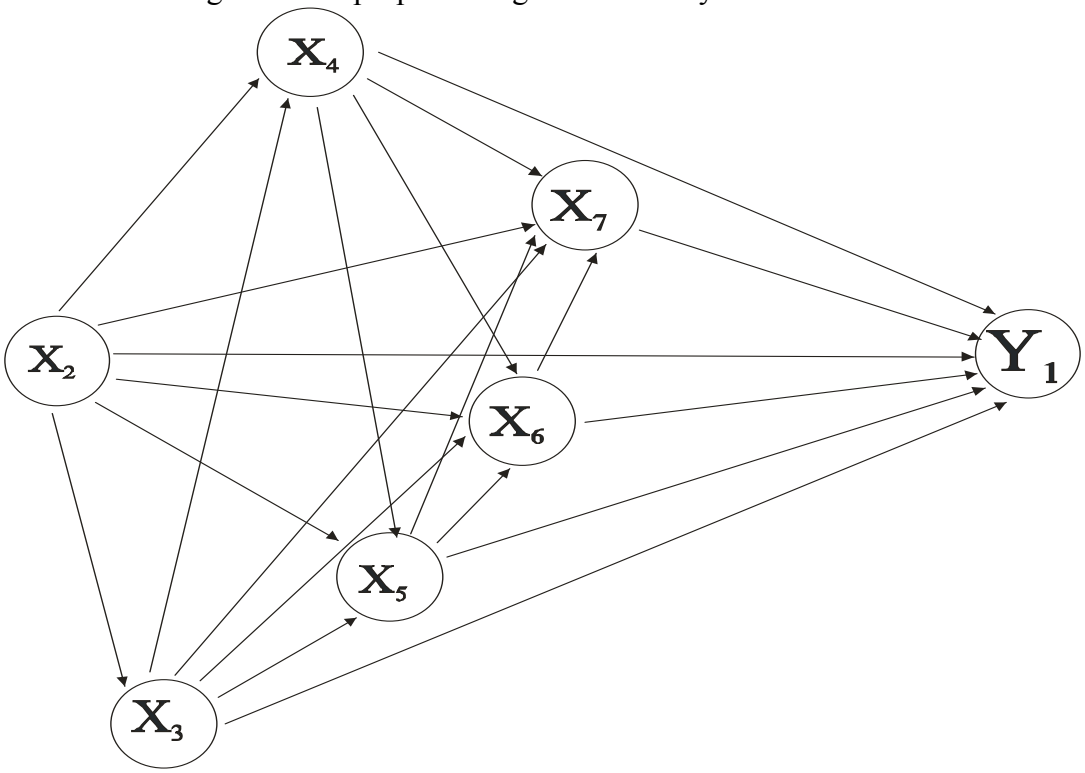

Figure 1: Hypothesized Path Model

Where Y_1 = Academic Achievement in Mathematics
X_2 = Self-concept
X_3 = Agreeableness
X_4 = Neuroticism

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X_5 = Conscientiousness
X_6 = Openness
X_7 = Extroversion

METHOD

The design adopted for this study is an ex-post facto/causal-comparative design that established both direct and indirect causal linkages between the personality factors and students' achievement in Mathematics. The study was conducted in the Akwa Ibom North West (Ikot Ekpene) Senatorial District. Ikot Ekpene Senatorial district is one of the three senatorial districts in Akwa Ibom State. It comprises ten (10) local government areas with ninety-two (92) public secondary schools (State Secondary Education Board, 2022). The main occupations in the area are craft (the raffia), civil and public services, and different businesses by men and women.

The population comprises all the public secondary schools in Ikot Ekpene Senatorial District. The total number of public secondary schools in Ikot Ekpene senatorial district is 92, and the total number of senior secondary two (SS2) students is 19227 (Akwa Ibom State Secondary Education Board, 2022). The sample for this study comprised Senior Secondary Two (SS2) students drawn from ten (10) sampled secondary schools. The collection of all the sampled students summed up to six hundred (600) students. The sample of 600 students out of the population of 19227 is justified and considered high enough for generalization based on Ajay and Micah's (2014) formula, which for a population of 15000, one needs only 390 as a sample; for a population of 25000, one needs only 394 as a sample. The sampling technique adopted for this study is proportionate random sampling and simple random sampling techniques. With 92 schools in the area, 10 schools representing 10.9% of the population were selected using simple a random sampling technique. It was actualized by writing the names of each of the 92 schools on pieces of paper, folding them into balls and placing them in a small carton box, shaking them vigorously; a student was asked to pick a ball without replacement for ten times to get 10 schools without being biased. The students were selected using a proportionate random sampling technique. The total number of SS2 students in the ten sampled schools was 5505, and 600 students representing 10.9% were selected. It was actualized by dividing the number of SS2 students in each sampled schools by the total number of SS2 students in the ten schools and then multiplying the result by the sample size (600). The proportion of students obtained was then selected randomly in each case.

The instruments used for this study are the Mathematics achievement test (MAT) and the personality factor scale (PFS). The researcher designed fifty (50) item objective Mathematics questions as an achievement test and forty-eight (48) item personality factor scales and administered them to the respondents. The achievement test measured the academic performance of the students in Mathematics, while the PFS measured the students' personalities. Content and face validity were adopted in testing the instruments for this study. Contents validity for the achievement test was ensured in constructing the test blueprint; the instruments were subjected to three experts in the field of Mathematics and Research, Measurement, and Evaluation for validation. Their input resulted in the final version used in

the study. The type of reliability adopted for this study is a measure of internal consistency because the instruments are dichotomous. The instruments were administered to a set of 30 students in another senatorial district of the State (Eket). Each correct item in the MAT scored 1 mark, while the wrong item scored 0. These scores were analyzed using the KR-20 reliability method, and a reliability coefficient of 0.93 was obtained. The Personality factor scale was an eight-item each of the personality factors (neuroticism, extroversion, openness, conscientiousness, agreeableness, and self-concept), making a total of forty-eight (48) items. The respondents were required to indicate the extent to which the given statement is applied to them on a four-point scale: Not at all (NAA), some of the time (SOT), most of the time (MOT), and all the time (ATT); and were awarded 1 point, 2 points, 3 points, and 4 points respectively. The scores were entered into the SPSS computer spreadsheet and were analyzed using Cronbach Alpha reliability. The reliability estimates for each factor were 0.87, 0.83, 0.92, 0.89, 0.90, and 0.94 respectively. Sequel to the reliability coefficients obtained, the instruments were considered highly reliable and fit for this study.

The instruments were administered by visiting the sampled schools and selecting the senior secondary two (SS2) students, and administered the instruments simultaneously to the students with the help of their form master or mistress. It took the researcher about two weeks to go to all 10 schools and collect the data. The Mathematics achievement test (MAT) consists of 50 items. Each correct item scored 1 mark, while the wrong item scored 0 marks. The personality factors scale consists of 48 items (8 items each of neuroticism, extroversion, openness, conscientiousness, agreeableness, and self-concept) structured on four points scale: Not at all (NAA), some of the time (SOT), most of the time (MOT), and all the time (ATT) and were awarded 1 point, 2 points, 3 points, and 4 points respectively. The scores were coded in a coding sheet and entered into a computer excel spread sheet. The computer was programmed to add the scores for the students in each of the sections of the questionnaire and that of achievement tests separately and recorded under appropriate labels for use in the data analysis:

X_4 = Neuroticism
X_7 = Extroversion
X_6 = Openness
X_5 = Conscientiousness
X_3 = Agreeableness
X_2 = Self-concept
Y_1 = Mathematics Achievement Test

To ensure that the scores were properly matched, each student was assigned a serial number. The procedure for analyzing the data was Path analysis. It was possible because it was multivariate and preferred because all the six predictor variables acted simultaneously with one another and the criterion variable. Moreover, interest is in studying patterns of causation among the variables in the model. Therefore, the data were inputted into the computer, and the Analysis of Moment Structure (AMOS) version of SPSS computer software was employed in running the path analysis.

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Hypothesized Recursive Path Model

Figure 2 shows the linkages among the personality variables X_i (i =2, 3, 4, 5, 6, and 7) and Mathematics achievement test (Y_1).

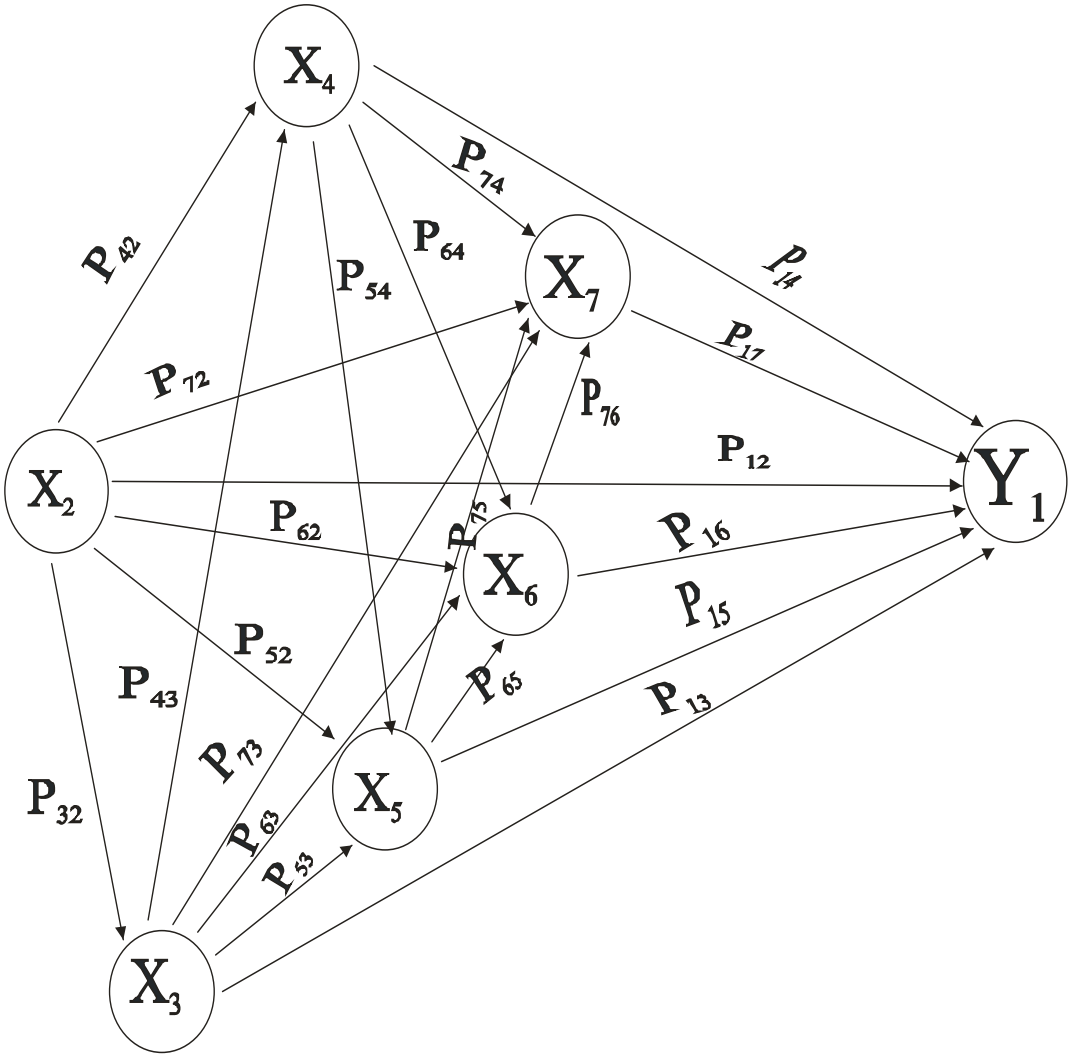

Figure 2: Hypothesized Recursive Path Model

RESULTS AND DISCUSSION

The hypothesized recursive path model shown in Figure 2 is reproduced in Figure 3 with the path coefficients and the zero-order correlation coefficients (in parenthesis). In trimming the paths in the model, paths were considered significant at 0.05 alpha level and meaningful if

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the absolute value of the path coefficient is at least 0.10. Sequel to these criteria (Table 4), the new path model was obtained in Figure 4, which shows the pathways that survived the trimming.

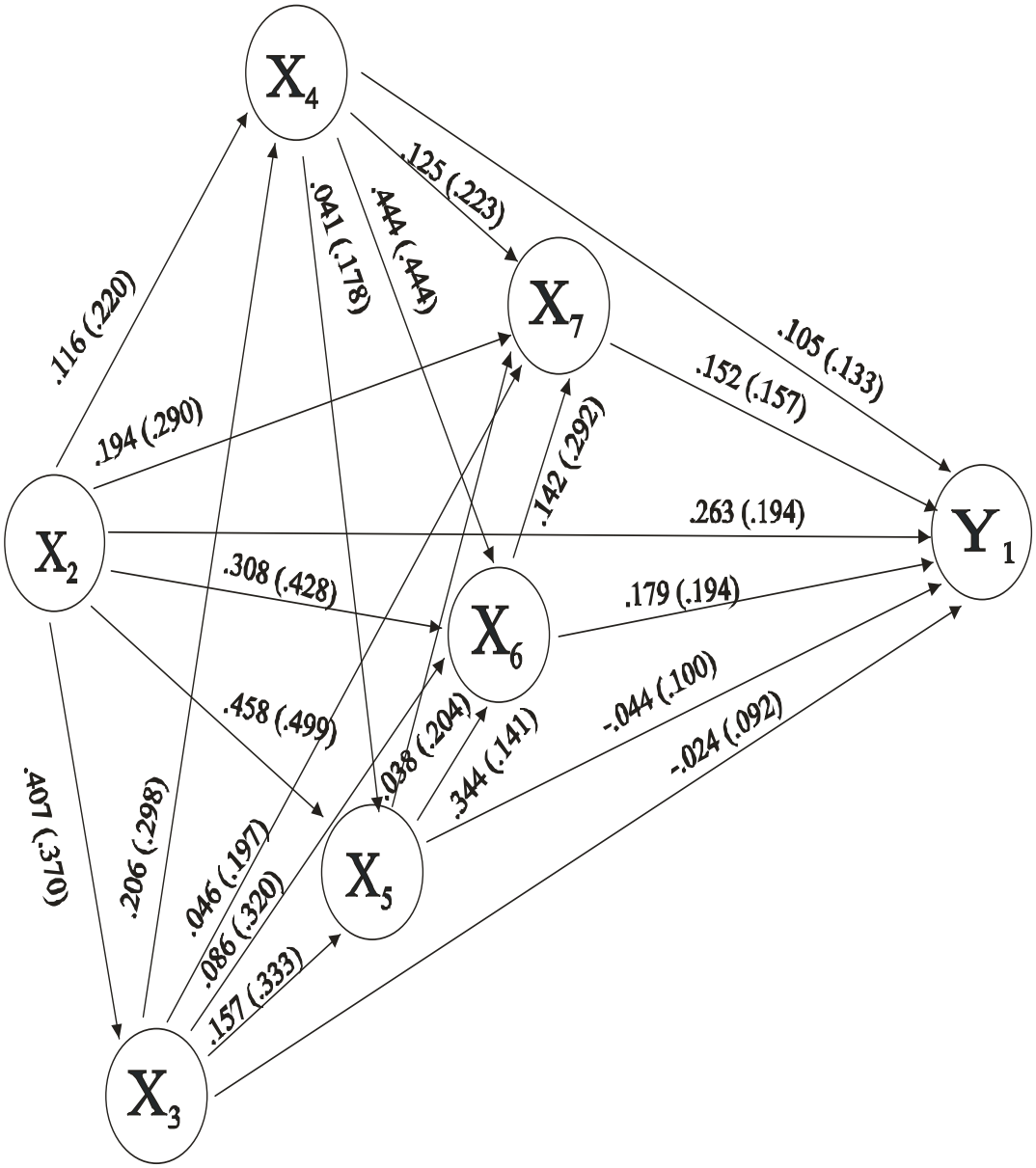

Figure 3: Hypothetical Recursive Path Model with Path Coefficients

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Table 4: Identified Paths for the New Model

Path	Weight (coefficient)	Remarks
P_{12}	0.263	** M
p_{13}	-0.024	NS NM
p_{14}	0.105	** M
p_{15}	-0.044	NS NM
p_{16}	0.179	** M
p_{17}	0.152	** M
P_{32}	0.407	** M
P_{42}	0.116	** M
p_{52}	0.458	** M
p_{62}	0.308	** M
p_{72}	0.194	** M
p_{43}	0.206	** M
p_{53}	0.157	** M
p_{63}	0.086	** M
p_{73}	0.046	NS NM
p_{54}	0.041	NS NM
p_{64}	0.444	** M
p_{74}	0.125	** M
p_{65}	0.141	** M
p_{75}	0.038	NS NM
p_{76}	0.142	** M

** = Significant at 0.05 alpha level.
NS = Not significant at 0.05 alpha level.
M = Meaningful, $|p_{ab}| \geq 0.10$.
NM = Not meaningful, $|p_{ab}| \leq 0.10$

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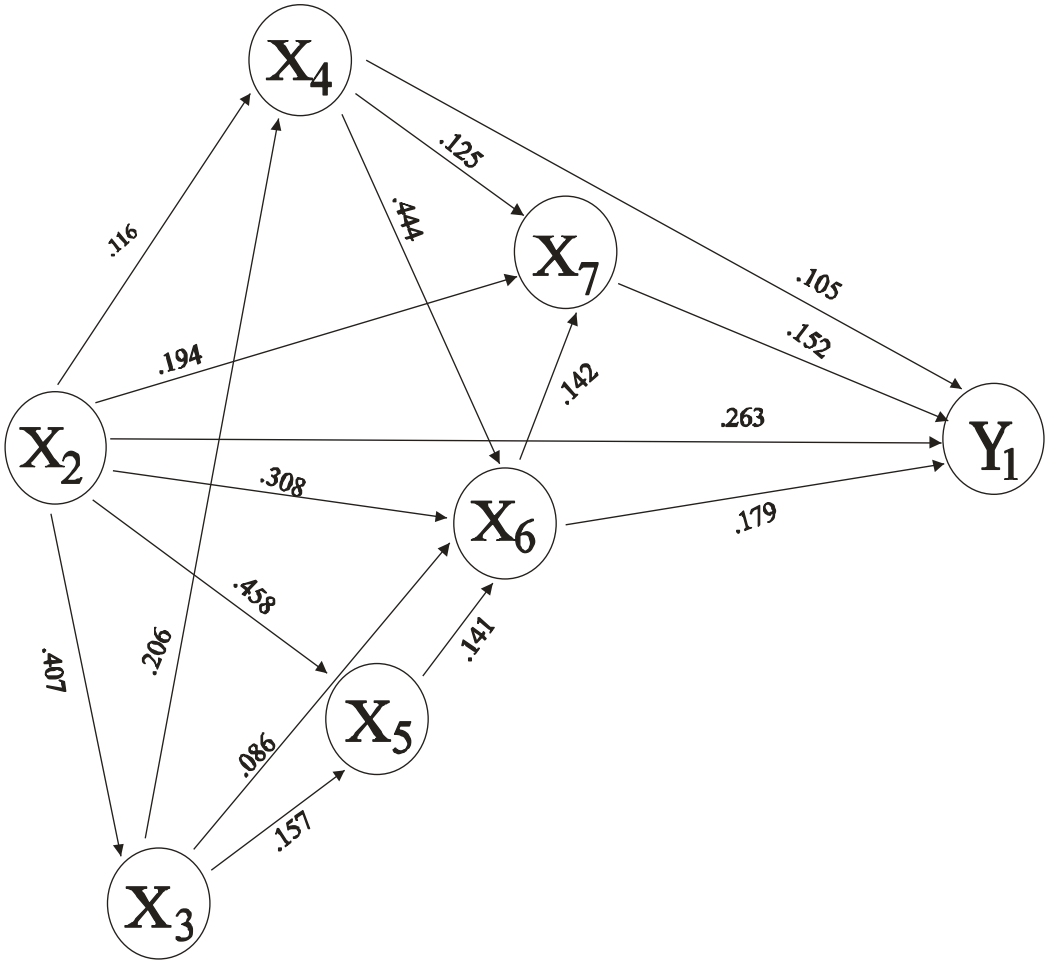

Figure 4: The New Path Model of Personality Determinants of Senior Secondary School Students' Achievement in Mathematics, christened *Udoukpong's model of students' personality factors as determinants of achievement in senior secondary school Mathematics.*

The efficacy of the new model was verified by comparing the reproduced correlation coefficients (using the new path model) to the original correlation coefficients (Table 4). From Table 4, the discrepancies between the original and the reproduced correlation coefficients are considered very small, with an average difference of 0.0245 (Table 6). It indicates that the pattern of correlation in the observed data is consistent with the new model. Hence, the model is considered tenable in explaining the causal interactions between personality factors and students' academic achievement in Senior Secondary School Mathematics. Thus, Figure 4 is the most meaningful causal model for achievement in Senior Secondary School Mathematics, christened *Udoukpong's model of students' personality factors as determinants of achievement in senior secondary school Mathematics*. The variables involved are self-concept, neuroticism, openness, and extroversion.

Table 5: Correlation Matrix for the Hypothesized Model (observed and reproduced correlation coefficient).

Variables	X_2	X_3	X_4	X_5	X_6	X_7	Y_1
X_2	1.000	0.370	0.220	0.499	0.428	0.298	0.194
X_3	0.407	1.000	0.298	0.333	0.320	0.197	0.092
X_4	0.200	0.253	1.000	0.178	0.444	0.223	0.133
X_5	0.530	0.354	0.041	1.000	0.344	0.204	0.100
X_6	0.506	0.248	0.450	0.141	1.000	0.292	0.194
X_7	0.253	0.126	0.190	0.058	0.142	1.000	0.157
Y_1	0.392	0.051	0.213	-0.010	0.201	0.152	1.000

[a] Entry above the diagonal are the observed correlation coefficients.
[b] Entry below the diagonal are the reproduced correlation coefficients.

Table 6: Discrepancy between original and reproduced correlation coefficients

Correlation	Original	Reproduced	Difference (x)
r_{23}	0.370	0.407	-0.037
r_{24}	0.220	0.200	0.02
r_{25}	0.499	0.530	-0.031
r_{26}	0.428	0.506	-0.078
r_{27}	0.290	0.330	-0.04
r_{21}	0.194	0.392	-0.198
r_{34}	0.298	0.253	0.045
r_{35}	0.333	0.354	-0.021
r_{36}	0.320	0.258	0.072
r_{37}	0.197	0.126	0.071
r_{31}	0.092	0.051	0.041
r_{45}	0.178	0.041	0.137
r_{46}	0.444	0.450	-0.006
r_{47}	0.223	0.190	0.033
r_{41}	0.133	0.213	-0.08
r_{56}	0.344	0.141	0.203
r_{57}	0.204	0.058	0.146
r_{51}	0.100	-0.010	0.09
r_{67}	0.292	0.142	0.15
r_{61}	0.194	0.201	-0.007
r_{71}	0.157	0.152	0.005

Average difference (x) = 0.0245

The study was conceived to understand some personality factors responsible for students' under-achievement in Mathematics, and develop a theory for teaching Mathematics at the Senior Secondary School level. The study undertook causal modeling of students' achievement in Mathematics with six (6) personality factors that may determine senior secondary school students' academic achievement. The study adopted an ex-post facto/causal-comparative design. Proportionate stratified random sampling and simple random sampling techniques were adopted for the study. The personality factor scale and Mathematics achievement test were the instruments used for data collection. Data were analysed using path analysis.

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The finding was that a new path model involving personality factors (neuroticism, extroversion, openness, conscientiousness, agreeableness, and self-concept) and academic achievement in Mathematics was produced and christened *Udoukpong's model of students' personality factors as determinants of achievement in senior secondary school Mathematics.* The pattern of the original correlation was consistent with the new model. It was found that four (4) personality factors (self-concept, neuroticism, openness, and extroversion) significantly determined senior secondary school students' achievement in Mathematics directly and indirectly. The other two (2) factors (agreeableness and conscientiousness) only determined senior secondary school students' achievement in Mathematics indirectly.

CONCLUSION AND RECOMMENDATIONS

The hypothesized pathways in this study (Figure 2) were reduced to significant and meaningful pathways (Figure 4). The efficacy of the new model was verified by reproducing the original correlation matrix of the variables. The verification of the model shows that the original correlation data are consistent with the new model. Hence, the new model is not rejected (it is retained). Therefore, figure 4 is the most meaningful causal model (involving neuroticism, extroversion, openness, conscientiousness, agreeableness and self-concept) for performance in senior secondary school Mathematics. Based on the findings, these recommendations were made:

i. Students should follow the causal order in the new model christened *"Udoukpong's model of students' personality factors as determinants of achievement in senior secondary school Mathematics*", in learning Mathematics. It is needful if they want to create more impact in society through Mathematics.

ii. Mathematics Teachers should work hard in providing an enabling environment for sustaining those factors in the model *"Udoukpong's model of students' personality factors as determinants of achievement in senior secondary school Mathematics"* capable of improving (determining) the teaching and learning of Mathematics in schools. It is achievable since the new model presents an effective model to teach and learn Mathematics at the senior secondary school level.

iii. Ministry of Education should study the new model of students' personality factors as determinants of achievement in senior secondary school Mathematics and then apply it as a model in future curriculum planning and development.

iv. Educational Researchers should use *"Udoukpong's model of students' personality factors as determinants of achievement in senior secondary school Mathematics"* to boost their empirical review.

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