Path Analysis of Psychological Factors as Determinants of Mathematics Performance of Secondary School Students in Calabar Education Zone, Cross River State, Nigeria

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Abstract
This study investigated psychological factors as determinants of Mathematics performance of secondary school students in Calabar Education Zone of Cross River State using path analysis. The study adopted ex-post-facto research design. The study made use of proportionate stratified random sampling technique in selecting 863 Senior Secondary School III students from 25 secondary schools in Calabar Education Zone. The instruments used for data collection were a 36-item structured questionnaire and 30-item multiple choice Mathematics Achievement Test (MAT). The reliability of the questionnaire was determined using Ordinal alpha reliability method while Kuder Richardson-20 method was used to determine the reliability of the MAT. Data analysis involved the use of Multiple Regression Analysis and Analysis of Moment Structure tested at .05 level of significance. Results showed that emotional intelligence, Mathematics self-efficacy, attitude towards Mathematics, Mathematics anxiety, study habit and academic procrastination significantly predicted students' academic performance in Mathematics. The results also revealed that 17 out of the 21 path-ways in the hypothesized path model met the criteria for significance or meaningfulness with six direct and 11 indirect path-ways. It was therefore recommended that attention to be directed towards the development of the affective domain of the students.
Keywords: Path analysis, psychological factors, Mathematics performance, secondary school students

INTRODUCTION

High academic performance in Mathematics is one of the top expectations of most parents, schools and the government. Regrettably, there have been continuous poor academic achievements in Mathematics among senior secondary school students nationwide in the West African Senior School Certificate Examination (WASSCE) indicating that the achievement as expected in Mathematics for global competitiveness looks illusive (Ekuri & Offiah, 2018). This problem is prominent in the previous results released by West African Examination Council which indicated continuous poor academic performance in Mathematics considering the percentage of those who obtained a minimum grade of C6 for many years. The evidence from the data from the Council showed poor academic achievement in Cross River State based on the State performance in the May/June WASSCE for six years in comparison with other states. Cross River State took the 21st position with 22.49% of the students obtaining minimum of 5 credits and above including English Language and Mathematics. Cross River State has constantly taken 20th position in the West African Secondary School Certificate from 2015 to 2019.

The Nigerian government, while trying to capture the situation through some enlightening associations have endeavoured to improve students' achievement especially in Mathematics by introducing new administrative plans and activities, new instructive programmes, to mention but a few, but still, all of these trials have not yielded the expected outcome considering the continuous poor academic performance in Mathematics among the students. Presumably, Mathematics has attracted the attention of both State and Federal Governments and even multinational organizations giving rise to a host of the National Mathematics quiz competitions. Despite all these efforts, meaningful solutions have not been reached to curb the issue of continuous poor performance in Mathematics among students.

No doubt, the utilization of different strategies in teaching Mathematics, by the teachers have caused little or no change as regards the problem of students' poor academic performance in the subject. The question therefore remains, Are teachers are not committed to their duties or are they not applying appropriate techniques to prepare the mind of the students? Many researchers have pointed accusing fingers with regards to the failure of the students, teachers, interestingly the same teachers who produced the best students are also held responsible for those that failed. This shows that there are other factors apart from the 'teacher effects' that could be responsible for the students' poor performance in Mathematics.

According to Soleymani and Rekabdar (2016), life today, which is a modern and complicated world requires creative thoughts and dynamic ideas. Learning Mathematics effectively can help an individual to form and grow well. Studying the effective parameters in learning Mathematics has been attractive to many scientists in the field of education during recent decades. Several research works have been carried out and the results showed that understanding Mathematics does not only depend on cognitive structures, but also on motivational and emotional factors such as belief, attitudes and anxiety. These factors are classified as psychological factors which include; emotional intelligence, Mathematics self-efficacy, attitude towards Mathematics, Mathematics anxiety, study habit, academic procrastination. Psychological factors can be positive, or negative, and these can also be further divided, to distinguish between trait and state aspects. In addition, cognitive, behavioural, and affective facets within psychosocial factors can be identified.

Researchers have pointed out that learners' emotional intelligence is one of the factors that determine the achievement of learners. Emotional intelligence can be considered a mental ability that involves the ability to reason validly with emotional information, and the action of emotions to enhance thought (Zhou, 2010). Emotional intelligence usually determines one's level of Mathematics self efficacy. Some studies have indicated that there is significant positive relationship between emotional intelligence and academic achievement among students in a manner that students with high emotional intelligence indicate preferable academic performance over the students with low emotional intelligence (Carvalho & Colvin, 2015; Ekuri & Offiah, 2018; Ghosh, 2014; Yelkikalan, Gungor, Kiray & Cetin, 2014).

However, the acquisition of efficacy in Mathematics is not easy as the students have to encounter a number of problems for learning Mathematics particularly during their school years. In this regard, the potential factors are the confidence of the students in the subject and their commitment to learning Mathematics. It was discovered that there was a significant positive relationship between self-efficacy and academic achievement (Hassan, Alasmari & Ahmed, 2015; Kirmizi, 2015; Olanrewaju & Joseph, 2014). On the other hand, achievement motivation has a great impact on students' academic performance and can also predict students' academic performance (Affum-Osei, Adom, Barnie & Forkuoh, 2014; Iseh, 2015; Muhammad, Bakar, Mijinyawa & Halabi, 2015).

There are times when students stayed later than usual in school because of the need to practise for din upcoming event. Hence, the students will not have time to check their notes and see whether they have assignments for the following day. Since they are already tired in school, these students will not be able to check their notes to see if they have assignments for the next day. When students do not acquire the necessary skills in Mathematics, their understanding of the advanced topics will be affected. If this case is left unresolved, it would lead to a negative attitude towards the subject which will usually affect students study habit and most of the students will see Mathematics as a difficult subject. It was also discovered that study habit significantly relates to students' academic achievement in Mathematics (Thankgod, Oyovwe, Magnus-Arewa & Nwaukwu, 2017). Also, academic procrastination hinders students' academic achievement (Hajali & Javad, 2015; Kim & Seo, 2015; Rafii, Saremi,

Najafi & Haghani, 2014).Consequently, the performance of the students will be affected and this can be explained by the use of path analysis.

Sewall Wright in 1921 presented the method of path analysis for estimating causal relations among variables based on the correlation matrix of observed variables, emphasizing path coefficients (standardized regression coefficients) but also using "path regressions"(unstandardized coefficients). He concocted a graphical strategy for introducing causal relations using path diagrams, consisting of variable labels connected by arrows for direct effects, double-headed arrows for unanalyzed correlations, and the estimated path coefficients listed over single-headed arrows (Wright, 1921). The typical steps in a path analysis study according to Eroğlu and Mercangöz (2013) is specifying the network of hypothesized direct and indirect casual links among the variables based on the theory, experience, and the literature. The paths in the hypothesized model are estimated after collecting the relevant data from a sample drawn from the population of interest.

In line with this, Pedhazur (1982) previously stated that in the causal model, distinction is made between exogenous and endogenous variables. According to Pedhazur, an exogenous variable is a variable whose variability is assumed to be determined by causes outside the causal model under consideration. In path analysis, an indirect effect occurs when a variable affects an endogenous variable through its effect on some other variable, known as mediating variables or intervening variable and this provides a more effective and direct way of modelling mediation, indirect effects, and other complex relationship among variables.

Thus, the use of a more detailed analytical tool has been found to be a better option as this gives a suggestive guide to a possible causal linkage among psychological factors and students' academic performance in Mathematics. This study proffers a possible causal model that could uncover the interactive effects of psychological factors in predicting academic performance in Mathematics among senior secondary school three students in Calabar Education Zone of Cross River State using path analysis.

RESEARCH QUESTIONS

The following research questions guided the study:

1. What are the relative predictive effects of psychological factors on students' academic performance in Mathematics?
2. What is the most meaningful and parsimonious causal model involving psychological factors and students' academic performance in Mathematics?
3. What are the direct and indirect effects of psychological factors as well as the estimates of the strengths of causation (path coefficients) of the variables in the model involving psychological factors and students' academic performance in Mathematics?
4. What proportions of the effect of psychological factors on students' academic performance in Mathematics are direct and indirect?

METHODOLOGY

The study adopted ex-post-facto research design and 5,751 Senior Secondary School III (SS3) students in the 84 public secondary schools in Calabar Education Zone. The study made use of proportionate stratified random sampling technique in selecting 863 SS3 students from 25 secondary schools in the Zone representing 30% of the schools in the Zone and 40% of the target population of 2,158 (the students in the selected schools). The instruments used for data collection were a 36-item structured 4-point scale titled "Psychological Factors Questionnaire" (PFQ) and 30-item multiple choice Mathematics Achievement Test (MAT). Each of the six sub-variables of psychological factors was measured with six items. The face and content validity of the instruments were determined by three research experts who satisfied the use of the instruments for the study. In determining the reliability of the instruments, a pilot testing was done using 30 students in one school in the area that was not part of the sample. The data collected for the reliability of the PFQ was analyzed using Ordinal alpha reliability method which gave reliability coefficients that

ranged between .77 and .85 while Kuder Richardson-20 method was used to determine the reliability of the MAT which gave a coefficient of .78.

Data collection for the main study was done in the sampled schools by the researchers. In doing this, the PFQ was first administered to the students and this was followed immediately with the MAT. Each of the subjects' responses in the PFQ and their scores in the MAT were matched together for analysis. The study involved the use of path analysis technique and path analysis afforded the researchers the opportunity to study the pattern of causation among the seven variables in the study as shown in the hypothesized path model. The hypothesized path model was built and derived from previous studies, temporal order and theory which helped in placing the variables accordingly

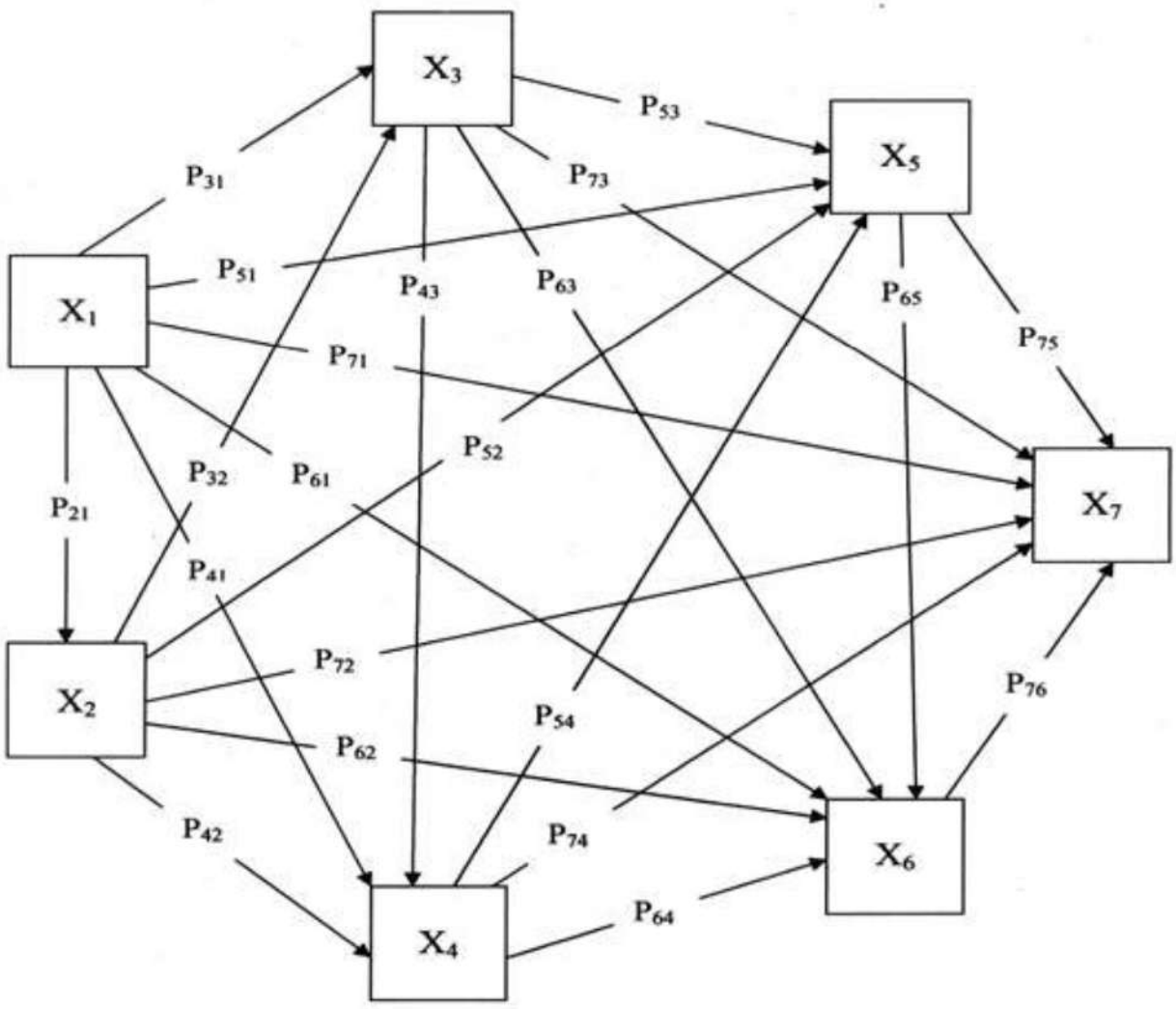

FIG. 1: The hypothesized path model for variables X_1 to X_7

Where: X_1=Emotional intelligence;
X_2=Mathematics self-efficacy;
X_3=Attitude towards Mathematics;
X_4=Mathematics anxiety;
X_5=Study habit;
X_6=Academic procrastination;
X_7= Academic performance in Mathematics

PRESENTATION OF RESULTS

Research question one
What are the relative predictive effects of psychological factors on students' academic performance in Mathematics?

To find out the relative contributions of each of the independent variables to the students' academic performance in Mathematics, a test of regression weight was carried out and the result is presented in Table 1.

TABLE 1: Test of regression weights for contributions of each of the psychological factors on students' academic performance in Mathematics

Multiple R	=	0.549
Multiple R^2	=	0.302
Multiple R^2 (Adjusted)	=	0.297
Standard Error of Estimation	=	4.128

Variables	B	Std. Error	Beta	t	p-value
(Constant)	6.760	1.213		5.572*	.000
Emotional intelligence	.356	.051	.267	6.990*	.000
Mathematics self-efficacy	.223	.047	.147	4.714*	.000
Attitude towards Mathematics	.182	.052	.131	3.489*	.001
Mathematics anxiety	-.240	.041	-.172	-5.860*	.000
Study habit	.152	.050	.108	3.034*	.002
Academic procrastination	-.136	.039	-.102	-3.467*	.001

Dependent variable: Students' academic performance in Mathematics

The result in Table 1 showed that the combined contributions of psychological factors to students' academic performance in Mathematics produced a coefficient of multiple regression (R) of 0.549 and an adjusted (standardized) multiple R-square (R^2) of 0.297. The adjusted multiple R-square (R^2) of 0.297 implies that when psychological factors were taken together, they accounted for 29.7% of the total variance in student's academic performance in Mathematics. The result further showed that the standardised regression weights (Beta) obtained for the psychological factors indicated that emotional intelligence with Beta value of 0.267, Mathematics self-efficacy with Beta value of 0.147, attitude towards Mathematics with Beta value of 0.131 and study habit with Beta value of 0.108 directly predicted students' academic performance in Mathematics while Mathematics anxiety with Beta value of -0.172 and academic procrastination with Beta value of -0.102 inversely predicted students' academic performance in Mathematics. In terms of magnitude of the contribution: emotional intelligence contributed most to the prediction of students' academic performance in Mathematics followed by Mathematics anxiety, Mathematics self-efficacy, attitude towards Mathematics, study habit and academic procrastination respectively.

Research question two
What is the most meaningful and parsimonious causal model involving psychological factors and students' academic performance in Mathematics? To test this hypothesis, the data collected were analysed to obtain the original correlation coefficients of the study variables and the path coefficients (Beta weights) for each of the pathways in the hypothesized model and the result is presented in Table 2 as well as in the parsimonious model in Figure 1.

TABLE 2:Significant and meaningful paths through which the independent variables determined academic performance in Mathematics

Path	Path coefficient	p-value
P_{21}	.275**	.000
P_{31}	.583**	.000
P_{32}	.082**	.004
P_{41}	-.096**	.026
P_{43}	.189**	.000
P_{51}	.313**	.000
P_{52}	.219**	.000
P_{53}	.243**	.000
P_{62}	-.143**	.000
P_{63}	-.083*	.056
P_{64}	.171**	.000
P_{71}	.267**	.000
P_{72}	.147**	.000
P_{73}	.131**	.001
P_{74}	-.172**	.000
P_{75}	.108**	.002
P_{76}	-.102**	.001

**Significant at $p<.05$

* Meaningfulness at path coefficient $\geq$. 05 in absolute sense

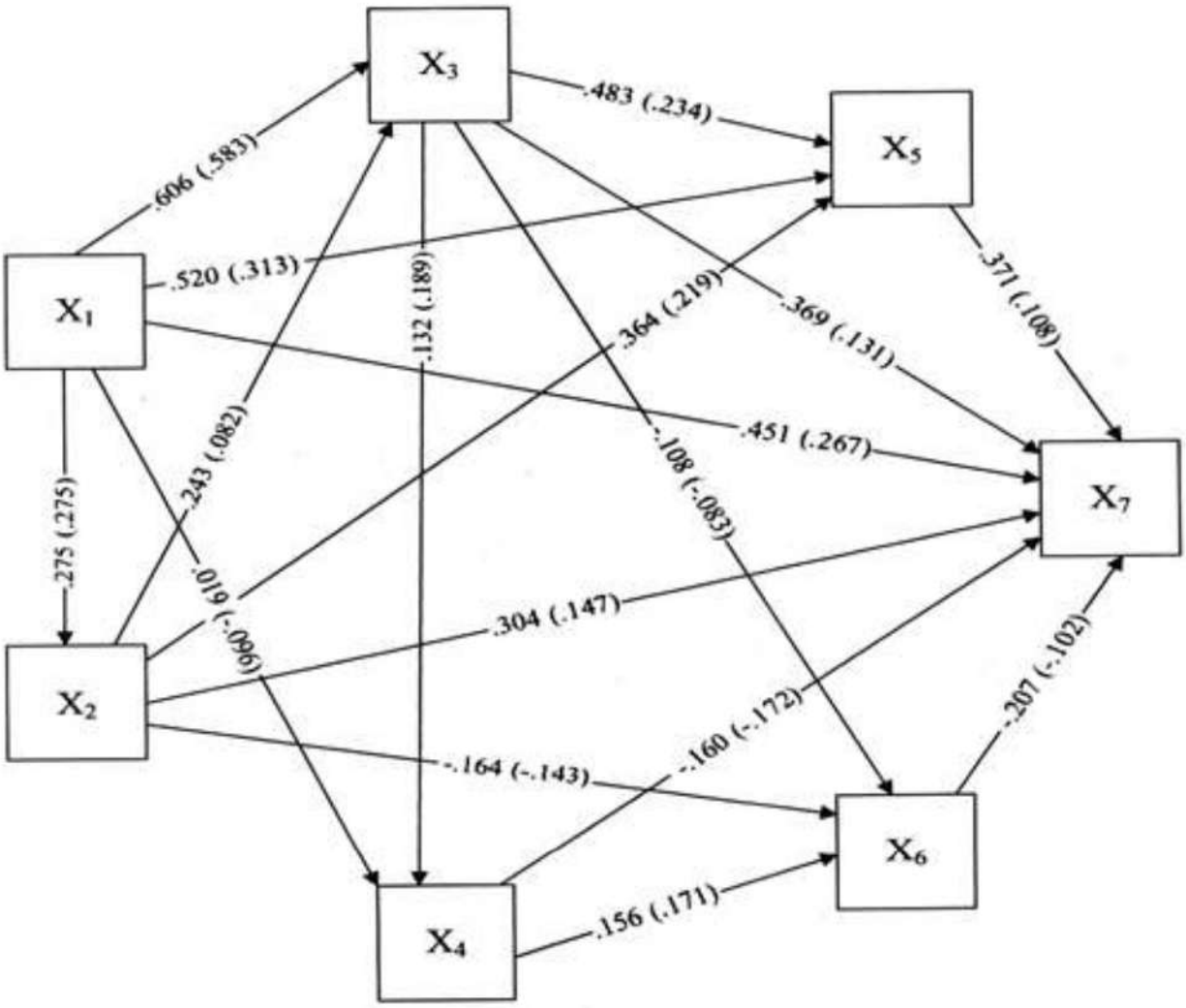

FIG. 2: A parsimonious model of psychological factors and academic performance of the students in Mathematics

From the new model, the following new sets of structural equations were obtained:

$X_1 = e_1$

$X_2 = P_{21}X_1 + e_2$

$X_3 = P_{31}X_1 + P_{32}X_2 + e_3$

$X_4 = P_{41}X_2 + P_{43}X_3 + e_4$

$X_5 = P_{51}X_1 + P_{52}X_2 + P_{53}X_3 + e_5$

$X_6 = P_{62}X_2 + P_{63}X_3 + P_{64}X_4 + e_6$

$X_7 = P_{71}X_1 + P_{72}X_2 + P_{73}X_3 + P_{74}X_4 + P_{75}X_5 + P_{76}X_6 + e_7$

The result indicated that out of the 21 pathways in the hypothesized model, 17 paths met the criteria for significance or meaningfulness as presented in Table 2 which was also illustrated diagrammatically in Figure 1. Any path with a p-value less than .05 is said to be statistically significant while a path whose beta weights is up to .05 and above is retained on a condition of meaningfulness even if they are not statistically significant Pedhazur (1982).

Figure 1 shows the parsimonious model involving the 17 survival paths for psychological factors and students' academic performance in Mathematics. This shows that after trimming using significance and meaningfulness of the paths, 17 out of the 21 hypothesized paths were retained. The numbers on each pathway indicates the original correlation coefficients and the beta weight (β) in brackets. The directions of the causal paths of the variables in the model are the pathways which are significant or meaningful as well as possess a link with the criterion variable (students' academic performance in Mathematics). This implied that Figure 1 can be used to explain the causal linkages (interactions) among the independent (predictor) variables and the dependent (criterion) variable.

Research question three
What are the direct and indirect effects of psychological factors as well as the estimates of the strengths of causation (path coefficients) of the variables in the model involving psychological factors and students' academic performance in Mathematics? The coefficient and nature of the paths on students' academic performance in Mathematics are presented in Tables 3.

TABLE 3: The coefficients and nature of the paths (direct and indirect) on academic performance in Mathematics

Path	Path coefficient	Nature of path	p-value	Remark
P_{21}	.275*	Indirect	.000	S
P_{31}	.583*	Indirect	.000	S
P_{32}	.082*	Indirect	.004	S
P_{41}	-.096*	Indirect	.026	S
P_{42}	.002	Indirect	.951	NS
P_{43}	.189*	Indirect	.000	S
P_{51}	.313*	Indirect	.000	S
P_{52}	.219*	Indirect	.000	S
P_{53}	.243*	Indirect	.000	S
P_{54}	-.025	Indirect	.359	NS
P_{61}	-.024	Indirect	.591	NS
P_{62}	-.143*	Indirect	.000	S
P_{63}	-.083	Indirect	.056	NS
P_{64}	.171*	Indirect	.000	S
P_{65}	.004	Indirect	.920	NS
P_{71}	.267*	Direct	.000	S
P_{72}	.147*	Direct	.000	S
P_{73}	.131*	Direct	.001	S
P_{74}	-.172*	Direct	.000	S
P_{75}	.108*	Direct	.002	S
P_{76}	-.102*	Direct	.001	S

S = Significant

NS = Not significant

The information in Table 3 showed that 15 out of the 21 paths have indirect effect on students' academic performance in Mathematics while the remaining six paths have direct effects on students' academic performance in Mathematics and all the six direct paths had significant effect on students' academic performance in Mathematics. From the analysis, it was found that there are significant direct as well as indirect effects of psychological factors on students' academic performance in Mathematics.

Research question four
What proportions of the effect of psychological factors on students' academic performance in Mathematics are direct and indirect?

The results of the multiple regressions were used to obtain information on the total effect, the direct and indirect effects of the indicator variables on the criterion variable. The result is presented in Table 4.

TABLE 4: Proportion of the direct and indirect decomposition of the effects of psychological factors on academic performance in Mathematics

Variable	DE	% of DE	IE	% of IE	TE	% of TE
Emotional intelligence	.267	21.98	.184	15.14	.451	37.12
Mathematics self efficacy	.147	12.10	.048	3.95	.195	16.05
Attitude towards Mathematics	.131	10.78	.035	2.88	.166	13.66
Mathematics anxiety	.172	14.16	.020	1.65	.192	15.80
Study habit	.108	8.89	.001	0.08	.109	8.97
Academic procrastination	.102	8.40	0	0	.102	8.40
Total	.927	76.30	.288	23.70	1.215	100

Key: DE = Direct effect
IE = Indirect effect
TE = Total effect
% = Percentage

The information in Table 4 revealed that the total effect (direct and indirect) of all the six indicator variables as well as the proportions of their direct and indirect effects are relative to the overall direct effect on students' academic performance in Mathematics. The proportion of the total direct to total indirect is approximately 76:24. The results also shows that the direct proportions of the effects of emotional intelligence, Mathematics self-efficacy, attitude towards Mathematics, Mathematics anxiety, study habit and academic procrastination on students' academic performance in Mathematics respectively were approximately 22.0%, 12.1%, 10.8%, 14.2%, 8.9% and 8.4% while that of the indirect proportions were 15.1%, 4.0%, 2.9%, 1.7%, 0.1% and 0%. The value of zero for academic procrastination indicated that it does not have indirect effect on students' academic performance in Mathematics.

DISCUSSION OF FINDINGS

The result revealed that psychological factors, when taken together, produced an adjusted (standardized) R^2value of .297 indicating that psychological factors accounted for 29.7% of the variance in the students' academic performance in Mathematics while 71.3% of the variance was as a result of extraneous variables not accounted for in the study. The result further indicated that the emotional intelligence, Mathematics self-efficacy, attitude towards Mathematics and study habit directly predicted students' academic performance in Mathematics while Mathematics anxiety and academic procrastination inversely predicted students' academic performance in Mathematics. This then implied that for each unit of emotional intelligence, Mathematics self-efficacy, attitude towards Mathematics and study habit added, the students' academic performance in Mathematics will improve while for each unit of Mathematics anxiety and academic procrastination added, the students' academic performance in Mathematics will decrease. These findings were as expected because emotional intelligence, Mathematics self-efficacy, attitude towards Mathematics and study habit promote students' academic performance in Mathematics while Mathematics anxiety and academic procrastination do not. Emotional intelligence, Mathematics self-efficacy, attitude towards Mathematics and study habit directly predicted students' academic performance in Mathematics while Mathematics anxiety and academic procrastination.

Emotional intelligence which is the ability to perceive emotions, to access and generate

emotions so as to assist thought, to understand emotions and emotional knowledge, and to reflectively regulate emotions so as to promote emotional and intellectual growth. Students who possess higher level of emotional intelligence are capable of keeping a check on their emotions better and be empathetic towards people around them. This will definitely assist them to develop improved self-motivation and possess effective communication skills which are essential in order to help others become more confident learners. On the other hand, students who lack emotional intelligence can become less connected to school which will negatively affect their academic performance in Mathematics. Self-efficacy in mathematics indicates students' self-belief in their ability to overcome difficulties or obstacles to solving mathematics problems. Such a belief has been shown to be important to motivation because confidence that one will be able to solve a problem is a precursor to investing the time and effort needed to tackle it. Mathematics' self efficacy can promote positive attitude towards Mathematics which will definitely improve the study habit of the student, while Mathematics anxiety might hinder students' study habit and this will give rise to academic procrastination.

The finding is in agreement with researchers who found out that there is significant positive relationship between emotional intelligence and academic achievement among students in a manner that students with high emotional intelligence indicate preferable academic performance over the students with low emotional intelligence (Carvalho & Colvin, 2015; Ekuri & Offiah, 2018; Ghosh, 2014; Yelkikalan, Gungor, Kiray & Cetin, 2014). The finding is in consensus with Hassan, Alasmari and Ahmed (2015), Kirmizi (2015) and Olanrewaju and Joseph (2014) who discovered that there is a significant positive relationship between self-efficacy and academic achievement. The finding is also in accordance with many researchers such as Affum-Osei, Adom, Barnie and Forkuoh (2014), Iseh (2015), and Muhammad, Bakar, Mijinyawa and Halabi (2015) who in their studies discovered that achievement motivation has a great impact with students' academic performance and can also predict students' academic performance. They concluded that academic achievement increases with the increase in achievement motivation. The finding also agreed with the study by Thankgod, Oyovwe, Magnus-Arewa and Nwaukwu (2017) that discovered that study habit significantly relates with students' academic achievement in Mathematics. The finding is also in line with Hajali and Javad (2015), Kim and Seo (2015) and Rafii, Saremi, Najafi and Haghani (2014), who found out in their studies that a significant negative relationship exists between academic procrastination and students' academic achievement.

The result revealed that out of the 21 pathways in the hypothesized model, 17 paths met the criteria of significance or meaningfulness as presented in Table 3 which was also illustrated in Figure 1. Figure 1 shows the parsimonious model involving the 17 survival paths for psychological factors and students' academic performance in Mathematics. This shows that after trimming by using significance and meaningfulness of the paths, 17 out of the 21 hypothesized paths were remained. It was also observed that out of the 17 pathways in the parsimonious model, six pathways were direct while 11 pathways were indirect. This is in accordance with the studies which stated that emotional intelligence is a relatively enduring trait and has ability to adaptively recognize, understand, manage, harness emotions both in oneself and in others, and use emotion to facilitate cognitive processing (Offiah, 2017). As regards the proportions of the direct and indirect effects of psychological factors on students' academic performance in Mathematics, it was observed that 76.3% of the proportion of the effect was direct while 23.7% was indirect. This is so because, for the students to perform well in Mathematics, they have to make adequate use of the combination of the psychological factors which will make them ease the importance of taking charge of their academics and set long term targets as regards their academics.

CONCLUSION

It was concluded that psychological factors such as emotional intelligence, Mathematics self-

efficacy, attitude towards Mathematics, Mathematics anxiety, study habit and academic procrastination play vital role on students' performance in Mathematics.

RECOMMENDATIONS

With regard to the research findings, the following recommendations were considered necessary.

1. Attention needs to be directed towards the development of the affective domain of the students, as a way of finding perfect solution to the continuous poor academic performance of students in Mathematics for global competitiveness.
2. Educational stakeholders, as a matter of urgency should give attention to developing the individual's emotional intelligence skills and achievement in Mathematics by establishing emotional intelligence training programmes in the school.
3. Students should be provided with a stimulating environment which will make them responsive towards problem-solving, knowledge, attitude and skills.
4. The school counsellors should inculcate values such as confidence, competence, effective use of time, good organization and so on among the students so as to reduce the attitude of not performing tasks as at when due.

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