Psychological Factors and Secondary School's Students Academic Performance in Mathematics

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Abstract: *This study was designed to predict students' academic performance in mathematics at the thinking level from students' psychological factors(Self-concept, test anxiety, interest in schooling, attitude towards mathematics, motivation and locus of control) and performance at the lower cognitive levels(knowledge and understanding). The survey made use of simple random sampling in selecting three hundred (300) Senior Secondary Two (S.S.2) students from six secondary schools in Calabar Metropolis of Cross River State, Nigeria. The students responded to two valid instruments: Students' psychological variables rating scale; and Mathematics achievement test. The students' psychological variables rating scale comprised of 40 questions which measured six variables. While the mathematics tests consisted of 60 questions which measured students' performance at three cognitive levels. Data analysis involved the use of multiple regression analysis. Results showed that students' psychological factors and students' achievement at knowledge and understanding levels are significant joint predictors of senior secondary students' performance in mathematics at the thinking level, and that such prediction could be done using the equation: Students' performance in mathematics(thinking)= 1.859 + 0.01(interest) + 0.021(attitude) − 0.041(Motivation) − 0.044(Self-concept) + 0.072(Test anxiety) − 0.041(Locus of control) +0.186(Knowledge) + 0.296 Understanding. It was observed that students' performance at the understanding level is the strongest predictor of their performance at the thinking level followed by performance at the knowledge level. It is concluded that certain factors are responsible for students' performance in mathematics. It is therefore recommended that teachers should provide enabling environment for sustaining lower cognitive abilities, which are capable of improving mathematics teaching and learning in our secondary schools.*

I. Background to the study

The problem of underachievement in mathematics among students, despite the fact that it is one of the core subjects recommended in the National Policy on Education has been a growing cause of concern amongst parents, teachers, researchers and the entire society (Umoinyang, 1999). From investigations, most secondary schools record the same pattern of poor mathematics performances year in, year out. The prediction of success or failure in mathematics is quite often based on cognitive variables usually assessed on Wechsler's (1996) intelligence scale. In an attempt to improve such predictions, there has been an upsurge of interest within the past few years on non-cognitive variables such as self-efficacy, self-concept, emotion, locus of control, interest, anxiety, self- esteem, self-identity but to mention a few.

Researches have shown that the behavior of students especially in relation to the sciences, generally and mathematics in particular is greatly influenced by certain psychological or non-cognitive factors. For example, Afemike (1985) found out that self-concept, attitude towards mathematics, sex-stereotyping, confidence, motivation and problem solving habit are all related to students' achievement. Other psychological factors which influence the performance of secondary school students in mathematics include self - concept, locus of control, study habit, career plan / aspiration, test anxiety, attitude towards mathematics, motivation, interest in schooling (Umoinyang, 1999). Olantunde (2010) showed in a research conducted on students' self-concept and Mathematics achievement that, students who have positive self-concept of themselves performed well in mathematics. The child who views himself and his abilities positively is the one who can maximally benefit and achieve good results in school learning experiences. Several investigations have also revealed that the attitude of the student to any particular subject may determine his/her performance in that subject. For instance, in a comparative study of factors influencing Mathematics achievement, Burstein (1992) found that there is a direct link between students' attitude towards Mathematics and their outcomes. Hence, students who have a poor attitude towards mathematics will show a high degree of inconsistency in overt action. Previous researches have also revealed that test anxiety has a debilitating effect on academic achievement of students (Julkunen, 1992; Ford, 1995; Schonwetter, 1995; Zanakis and Valenzi, 1997). Some of these studies have associated high test anxiety with low achievement.

Albero, Brown, Eliason and Wind (1997) found that children with high test anxiety had significantly lower scores. Similarly, Schonwetter (1995) found that test anxiety yielded differences in student learning outcomes and that high test- anxious students were unable to benefit directly from organized instruction though organized instruction did increase students' motivation to attend future classes.

Achievement motivation is another important factor in prediction of students' performances. Boggiano (1992) revealed that achievement motivation positively influenced academic performance. Highly motivated students performed better academically than lowly motivated students (Tella 2007) and females are highly motivated compared to their male counterparts (Sikwari 2014). The influence of achievement goals may also be moderated by the extent to which students attribute success or failure to internal or external factors, i.e., factors under or not under their control. This attribution, called locus of control, has been extensively investigated using Rotter's (1966) scale that identifies respondents as either "internals" or "externals." Internals believe that events primarily result from their own behavior. For example, success on an examination is attributable by internals to their effort. Externals believe that events primarily are the result of chance or someone else's actions. In an academic context, an external would likely consider failure on an examination to be the result of an unfair test (teacher's fault, for example). By itself, locus of control can have important implications. Gifford et al. (2006), for instance, find that college freshmen who were identified as internals obtained significantly higher GPAs and Carden et al. (2004) found that internals showed significantly lower academic procrastination, debilitating test anxiety, and reported higher academic achievement than externals. These and many other reasons emphasized the need to bring into focus the present study which is designed to consider each of the following psychological factors and examine their relationship with academic achievement in mathematics: Self-concept, test anxiety, interest in schooling, attitude towards mathematics, motivation and locus of control since a better understanding of the influences of psychological variables on mathematics achievement would be of considerable help in developing and enhancing a more effective method for teaching mathematics at various levels. This in turn will enhance achievement in the subject, which is our ultimate goal.

Interest in Schooling and academic achievement: The past years have witnessed the evolution of research pertaining to interest. Several studies concerned with the effect of interest factors on academic achievement in secondary schools have yielded positive result. Adeyemo (2005) posits that the importance of interest in whatever a person does cannot be underestimated. He asserts that when it comes to making choice, interest is of considerable importance. Previous studies of Benton and Associates (1995) found out that a significant interaction existed between interest and academic achievement. Rolflus and Ackerman's (1996) study findings also posited that there is a positive correlation between mathematics knowledge and interest. Koller *et al.* (2001) argued that the role of interest is particularly relevant in mathematics because it is perceived as a very difficult subject in which motivational factors are very important for enhancing academic achievement. Findings on empirical relations between interest, learning and achievement have also indicated that interest-based motivation has favourable effects on both the process and the outcome of learning (Schiefele, 1991, 1996; Hidi and Reninger, 1992; Krap, 1998). Similarly, Tella (2003) and Adeyemo (2005) report on significant prediction of academic achievement by interest in schooling. Odinko and Adeyemo (1999) found that interest in schooling together with other socio-psychological factors are good predictors of students' learning outcome and attitude to English language.

Attitude to mathematics and academic achievement: Literature refers to attitude as a learned predisposition or tendency of an individual to respond positively or negatively to some object, situation, concept or another person. This positive or negative feeling is of moderate intensity and reasonable stability; sometimes it is especially resistant to change. In the variety of definitions of attitudes towards Mathematics (ATM) proposed in research studies, two main categories can be identified. Using a simple definition, ATM is just a positive or negative emotional disposition towards Mathematics (Mc Leod, 1994). Using a multidimensional definition, ATM comprises three components: an emotional response to Mathematics, positive or negative, a conception about Mathematics, and a behavioral tendency with regard to Mathematics (Hart, 1989). Current efforts in Mathematics education reform are driven by the belief that all students can learn. Motivation needs have led researchers to study the relationship between ATM and achievement. To assess the magnitude of this relationship, Ma and Kishor (1997) conducted a meta-analysis on 113 primary studies. They found that attitude towards Mathematics and achievement in Mathematics was positively and reliably correlated but not strong. The correlation was not statistically significant. Some studies have demonstrated a strong and significant relationship between Mathematics attitude and Mathematics achievement (Randhawa & Beamer, 1992, Schenkel, 2009). In the Schenkel's (2009) study of elementary school pupils, positive correlation between student attitude and student performance was found. Student beliefs and attitudes were found to have the potential to either facilitate or inhibit learning.

In a comparative study of factors influencing Mathematics achievement, Burstein (1992) found that there is a direct link between students' attitudes towards Mathematics and student outcomes. Cheung (1998), in his study of 11-13 year olds, also discovered positive correlation between attitude and Mathematics achievement. The correlation showed that the more positive the attitude, the higher the level of achievement in the student.

Among the other major findings, Khatoon and Mahmood (2010) showed that students generally had positive attitudes towards mathematics and science, and that there is a positive relationship between mathematics attitudes and mathematics achievement. In another study, Goe and Croft (2009) showed that those who have positive attitudes toward mathematics have better performance in this subject. In contrast with these findings, Boyd et al. (2008) showed that for the third grade students there was no significant relationship between students' attitude toward mathematics and students' achievement in this subject.

Self - concept and academic achievement: Researches have supported the belief that there is a persistent and significant relationship between self-concept and academic achievement, and the change in one seems to be associated with a change in other (Marsh, 1992). Olantunde (2010) showed that students who have positive self-concept of themselves performed well in mathematics. Studies have also shown that better self-concept is associated with better scholastic achievement test (Raju, 2013) and has a significant relationship with academic achievement (Sikhwara, 2014; Archana & Chamudeswari, 2013).

Achievement Motivation and Academic Achievement: Motivation has been found to affect attitudes by causing students to have more positive attitudes and confidence in themselves (Burris, Heubert, & Levin, 2004). According to Ellis (2010), motivation positively affects achievement with the two existing in a cycle so that as one increase the other increases. In a research comprising several field studies and laboratory experiments, Boggiano (1992) revealed that achievement motivation positively influenced academic performance. It was found that motivational orientation predicted children's standardized achievement scores (Boggiano et-al 1992). Children with an intrinsic motivation orientation had higher reading and math scores and higher overall achievement scores compared to their extrinsic counterparts (Boggiano *et al,* 1992). According to Sikwari (2014), there is a significant correlation between academic achievement and motivation, and females are highly motivated compared to their male counterparts. In another study, highly motivated students performed better academically than lowly motivated students and motivation has impact on academic achievement of secondary school students in mathematics with respect to gender (Tella, 2007)

Test anxiety and students' academic achievement: Tobias (1993) defines mathematics anxiety as feelings of tension and anxiety that interferes with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations and can cause one to forget and loose one's self-confidence. Test anxiety is a learned behavior, which can be unlearned. It is developed when students fail to prepare adequately for evaluative programmes. Some things that can create test anxiety are: parents, friends or teachers that may pass their bias to the student to make them believe that there is a connection between grade and self-worth, fear of alienating parents, family or friends due to poor grades, anxiety that may be due to not feeling that they are not in control. The cognitive theory of test anxiety (Meichenbau & Butler, 1980; Sarason, 1975; Wine, 1980; Umoinyang, 1999) has three common components that are very important to consider in a study like this. The first is that high level of test anxiety is believed to adversely influence students' self-appraisals of evaluative situation. Secondly, test-anxious students are prone to engage in more negative thoughts (negative internal dialogue) during evaluative tasks. Thirdly, students' performance attributions are believed to be influenced by high levels of test anxiety.

Researches have shown that cognitive test anxiety causes poor performance in cognitive tasks (Cassady, 2004; Cassady, Mohammed & Mathieu, 2004; Olatoye, 2007). It was found to have correlated negatively with performance scores in cognitive tests (Adigwe, 1997). The report of Umoinyang (1997) also confirms that test anxiety has a significant impact on academic achievement. His study adopted the one-shot case experimental research design. 80 final year students were randomly sampled from public secondary schools in Calabar municipality. Results indicated that test anxiety independently is a significant predictor of mathematics achievement of students. Findings from literature also reveal that cognitive test anxiety is to a large extent, dependent on the type of test or examination administered. When the preferred item format is used to conduct test, students demonstrate low cognitive test anxiety level, and this in turn leads to high score in cognitive tests (Olatoye, 2007).This is because such test formats does not require much cognitive processing especially the multiple choice test formats which only require selection of correct options. Therefore student do not need to spend hours preparing for such tests as one can even guess.

Locus of control and students' academic performance: The attribution, called locus of control, has been extensively investigated using Rotter's (1966) scale that identifies respondents as either "internals" or "externals." Internals believe that events primarily result from their own behavior. For example, success on an

exam is attributable by internals to their effort. Externals believe that events primarily are the result of chance or someone else's actions. In an academic context, an external would likely consider failure on an exam to be the result of an unfair test (teacher's fault, for example). By itself, locus of control can have important implications. Gifford, Bricelo-Perriott and Mianzo (2006) for instance, found that college freshmen who were identified as internals obtained significantly higher GPAs and Carden et al. (2004) found that internals showed significantly lower academic procrastination, debilitating test anxiety, and reported higher academic achievement than externals. Furthermore, Weymer (2002) justified in his findings that locus of control was firmly related to academic achievement; he mentioned that more than 40 studies had investigated the relationship between perceptions of locus of control and students' academic achievement. Although the results were somewhat inconsistent, internal perception of control tends to be positively correlated with academic achievement.

Amadi (2010) and Araromi (2010) in their studies posit that both internal and external locus of control are important predictors of academic achievement. Araromi defines this sense of control or locus of control as the extent to which an individual believes that he or she has control over an outcome. Also Eduwem (2013) in her study discovered that there is a significant influence of locus of control on JSS 3 students' performance in mathematics and that locus of control is a significant factor in students' classroom learning especially in spatial subjects like mathematics. The study further revealed that students' with an internal locus of control performed significantly better than those with external locus of control. Many other studies have identified significant relationships between locus of control and academic achievement satisfaction. Studies conducted by Adeyinka, Adedeji and Adeniyi (2011) examined locus of control, interest in schooling and self-efficacy as predictors of academic achievement of Junior Secondary School Students. The results indicated that locus of control, interest in schooling and self efficacy jointly and relatively contribute significantly to the prediction of academic achievement of the Junior Secondary School Students. Abe (1995) found out that there was no direct effect of locus of control on students' achievement in social studies in his study of the causal linkages between academic achievement and some socio-psychological variables using a sample of 624 junior secondary school class three students in 30 secondary schools in Oyo state. But there was an indirect effect of locus of control through attitude towards social studies; and another composite indirect effect through attitude and study habit.

II. Methodology

The present research adopts the causal-comparative design. The population for the study comprised of Senior Secondary Two (S.S. 2) students in Calabar Metropolis of Cross River State, Nigeria. Three hundred (300) students were randomly drawn from six secondary schools in Calabar Metroplis out of a total of 20 public secondary schools and 26 private secondary schools. The instruments used for this study were Students' psychological variables rating scales (SPVRS) and Mathematics Achievement Test (MAT) developed by the researchers. The SPVRS is a 4 - point Likert Scale. The MAT is a sixty (60) item multiple choice test. The instruments were administered to the subjects in their respective schools. The administration of the test was done by the researcher with the assistance of some staff of the selected schools. A total of two hundred and eighty-nine (289) respondents completed and returned their instruments at the end of the exercise. On the whole, the data collection exercise lasted for one week.

III. Results And Discussion

The only hypothesis of this study was that psychological factors and lower cognitive ability in mathematics are not significant predicators of students' performance in mathematics at the thinking level.

The independent variables, otherwise called predicators involved in this hypothesis are: Interest in schooling, attitude towards mathematics, motivation, self-concept, test-anxiety, locus of control, performance at knowledge level and performance at understanding level. The dependent variables, which is the criterion variable is students' performance in mathematics at the thinking level. The statistical analysis technique used in testing this hypothesis is the regression analysis (the enter mode). The inter-correlation coefficients among the variables in the prediction are shown in Table 1, while the regression analysis results are shown in Table 2

TABLE 1: Inter-correlation among Students' Psychological factors and performance in Mathematics

Variable	Interest	Attitude	Motivation	Self Concept	Test Anxiety	Locus of Control	Knowledge	Understanding	Thinking
Interest	1.000	.244*	.204*	.076	.058	-.102*	.161*	.099	.114*
Attitude	.244*	1.000	.213*	.326*	.274*	-.231*	.159*	.072	.119*
Motivation	.204*	.213*	1.000	.085	.020	0.005	-.045	-.117*	-.060
Self-concept	0.76	.326*	.085	1.000	.400*	-.012	.169*	.169*	.106
Test-anxiety	.058	.274*	.020	.400*	1.000	-.106*	.214*	.181*	.200*
Locus	-102*	-.231*	.005	-.012	-.106*	1.000	-.257*	-.189*	-.212*

control									
Knowledge	.161*	.159*	-.045	.169*	.214*	-.257*	1.000	.758*	.644*
Understanding	.099*	.072	-117*	.169*	.181*	-.189*	.758*	1.000	.656*
Thinking	.114*	.119*	-.060*	.106*	.200	--.212	.644*	.656*	1.000

Multiple Correlation R = .699; R^2 = .489   *Significant at 0.05 level 0f significance

TABLE 2: MULTIPLE REGRESSION ANALYSIS OF THE PREDICTION OF STUDENTS' PERFORMANCE IN MATHEMATICS USING THEIR PSYCHOLOGICAL FACTORS AND PERFORMANCE AT LOWER COGNITIVE LEVEL

SOURCE OF VARIATION	SS	df	Ms	F-Ratio	Significant
Regression	1416.973	8	177.122	33.457	.000
Residual	1482.307	280	5.294		
Total	2899.280	288			

VARIABLE	REGRESSION WEIGHT (B)	STANDARD ERROR	t-VALUE	SIGN. OF t
Interest	0.011	.038	.296	.767
Attitude	0.021	.037	.551	.582
Motivation	-0.004	.048	-.078	.938
Self-concept	-0.044	0.04	-1.098	.273
Test-anxiety	0.072	0.050	1.428	.155
Locus of control	-0.041	.047	-0.874	.383
Knowledge	.186	.039	4.710*	.000
Understanding	.296	0.49	6.024*	.000
Constant	1.859	1.61	1.155	.249

* Significant at 0.05 level

IV. Prediction Equation

Achievement in math (thinking) = 1.859+0.01 interest in schooling + 0.021 Attitude towards mathematics - 0.004 motivation - 0.044 self-concept + 0.072 Test anxiety - 0.041 locus of control + .186 Knowledge + .296 Understanding.

Table 1 shows the inter-correlations among the eight variables involved in the hypothesis. Almost all the bi-variants Pearson's correlation coefficients are significant at 0.05 level. The result in Table 1 also shows that there is a significant linear relationship between students' performance in mathematics at the thinking level and interest in schooling, Attitude towards mathematics, self-concept, test-anxiety, locus of control, performance at knowledge level and performance at understanding level. However, there is a negative relationship between locus of control and students' performance at the thinking level. This means that as locus of control increases in the student, performance in mathematics decreases. But motivation does not significantly relate to students' performance in mathematics at the thinking level. The multiple correlation among the variables (R = 0.699) is also significant at 0.05 level significance. The percentage of variance in the predicted variable accounted for by the predictors (R^2) is 48.9%, and this is very high. This means that 48.9% of the performance of students in mathematics at the thinking level is due to a linear combination of students' psychological factors: Interest in schooling, attitude, motivation, self-concept, test-anxiety, locus of control, and their performance at knowledge and understanding levels.

Table 2 shows the multiple regression results, the regression weights for the independent variables (Predictors) and the t-values that tested the significance of the regression weights. The table shows that the prediction of students' performance in mathematics at the thinking level from students' psychological factors and performance at the lower cognitive level is significant (F=33.457; p<0.05). The table also shows that only the t-values for the prediction weights of performance at the knowledge and understanding levels are statistically significant at 0.05 level. Since the regression weights indicate the relative strength of the predictors, it therefore means that students performance in mathematics at the thinking level can be predicted by the amount of achievement at the knowledge level (β = 0.186; t = 4.71) and their performance at the understanding level (β = .296; t = 6.024); and by their psychological factors which are interested in schooling (β = 0.011; t = 0.296); Attitude towards mathematics (β = 0.021; t = 0.551) motivation (β = 0.072; t = 1.428); and locus of control (β = -0.041; t = -0.874).

From Table 2, such prediction is applicable using the prediction equation:

Students' performance in mathematics (thinking) = 1.859 + 0.01 (interest in schooling) + 0.021 (attitude towards mathematics) - 0.004 motivation - 0.044 self-concept + 0.072 test anxiety -0.041 locus of control + 0.186 knowledge + 0.296 understanding.

That is, if a student's scores on interest in schooling, attitude towards mathematics, motivation, self-concept, test anxiety, locus of control, performance in mathematics at the knowledge level and performance in mathematics at the understanding level are obtained, his/her score in mathematics at the thinking level could be determined using this equation. The table also shows that students' performance in mathematics at the understanding level is the strongest predictor of their performance at the thinking level followed by performance at the knowledge level. The negative sign for the regression weight of motivation, self-concept and locus of control indicate that the prediction by these variables is in the reverse direction. That is, the higher the motivation, self-concept and locus of control, the less the performance of the students in mathematics at the thinking level.

V. Discussion

From the findings of this study, students performance in mathematics at the thinking level could be predicted by the psychological factors: Interest in schooling, attitude towards mathematics, motivation, self-concept, test anxiety, locus of control and students performance in mathematics at the lower cognitive levels (knowledge, understanding) using that prediction equation. From this equation, it is clear that a positive interest in schooling enhances students' achievement in mathematics at the thinking level. Clearly from this result, students' performance in Mathematics at a higher cognitive level depends on some psychological factors and their performance at the lower cognitive levels. The finding is in line with findings of previous studies of Benton and Associates (1995) who found out that a significant interaction existed between interest and academic achievement (r = .53). This result is also similar to Rolflus and Ackerman's (1996); Schiefele (1991); Hidi and Reninger (1992); Krap's (1998) findings that there is a positive correlation between mathematics knowledge and interest.   It was also seen that positive attitude towards mathematics enhances achievement in mathematics at the thinking level. This result indicates that there is a positive relationship between attitude and academic achievement. The result confirms the belief of Cheung (1998); Burstein (1992) ; Ma and Kishor (1997); Khatoon and Mahmood (2010); Goe and Croft (2009) who found a positive relationship between attitude and academic achievement. The result also explains the fact that a positive attitude to studies can predict academic achievement. Some other studies have demonstrated a strong and significant relationship between Mathematics attitude and Mathematics achievement (Randhawa & Beamer, 1992; Schenkel, 2009). However, findings of Boyd et al (2008) did not reveal any significant relationship between attitude and academic achievement.

The present finding revealed a negative relationship between motivation and academic achievement. This finding is not unexpected. The negative relationship so observed could be interpreted to mean that under harsh academic climate where study conditions are not conducive for learning, for instance, the number of students in a given class exceeds fifty; the attention given to each student may not be adequate enough to stimulate and motivate the students to achieve. Results from the analysis also reveals a positive relationship between self-concept and academic achievement means that if one feels that he is able to perform a task he/she will work hard to maintain such feelings. The result is in line with the findings of Marsh (1992) who came out with a result that students' self-concept is positively related to their level of academic performance. The result is also in line with the findings of Olantunde (2010); Raju (2013); Archana and Chamudeswari (2013); Sikhwara (2014) who showed in a research conducted on students' self-concept and Mathematics achievement that, students who have positive self-concept of themselves performed well in mathematics. However, the relationship between self-concept and academic achievement is often debated.

The result also that shows that test anxiety has a significant positive relationship with academic achievement. This result is also in line with the findings of Umoinyang(1997) and Adigwe (1997). The relationship of locus of control with achievement at thinking level agrees with Abbe's (1995) belief that there was no direct effect of locus of control on students' achievement in social studies.   It is also clear from the results that mathematics achievement at understanding level is the strongest predictor of students' academic performance at the thinking level.

VI. Conclusion

Based on the findings of this study, it is concluded that students' performance at a higher cognitive level of mathematics depends heavily on some psychological factors of the students and their footing at the lower cognitive level of performance in Mathematics.

VII.   Recommendations

The following recommendations are made on the basis of the results obtained from the study.

1. Teachers should provide an enabling environment suitable for sustaining achievement at lower cognitive abilities in our secondary schools.
2. teachers should use the scales used in this research to measure the psychological factors of students to determine the kind of treatment given to Secondary School students if their performance is needed to change the service delivery in the sector.
3. This study should be replicated to other educational zones of Cross River State, in Nigeria and beyond.
5. That schools' counselors and administrators should use this prediction equation in predicting students' academic performance when it is not expedient for administrative scores to be registered.

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