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A Measure of the Influence of Affective Variables on Mathematics Performance at Lower Secondary

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Abstract

In Mauritius, government average annual spending on education is 12% (US$ 400 million) of the total expenditure. Despite the massive investment in education, every year around 50% of students fail to obtain at least a grade C in mathematics at 'O' Level. Current research literature indicates that there are many factors that may lead to such poor performance in mathematics, ranging from social to academic. However, it is suggested that research in mathematics education can be strengthen with the integration of affective issued into studies of cognition and instruction. The purpose of this study is to examine the effect of three school related constructs - Attitude, Motivation and Perceived usefulness of Mathematics - on mathematics performance at lower secondary level in Mauritius. A sample of 775 grade 8 students (13 years old) from 13 secondary schools was involved in 2011. Structural Equation Models (LISREL 9.0) was used to measure the influence of affective variables on mathematics achievement. It is found that the three affective variables account for 25% of variances in mathematics performance at lower secondary level. Attitude had greatest influence on mathematics achievement. Perceived usefulness of mathematics had a strong positive influence on attitude, a positive influence on motivation but a negative direct influence on mathematics performance. Motivation had a weak influence on mathematics performance. The findings suggest that teacher training program should address the issue of students' motivational and attitudinal problem. Students should be made aware of the importance and usefulness of mathematics in everyday life, in particular, for higher studies and in the labour market.

Key Words: Attitudes, Motivation, Mathematics Usefulness, Performance

Introduction

Recently, there has been an increased interest in the role of affective variables in the learning of mathematics (Leder and Forgasz 2006; Schuck and Grootenboer 2004). Research evidences provide substantial amount of data that justify concerns about affective variables. For example, Dossey *et al.* (1988) found that students become less positive about mathematics as they proceeded through school, whereas Drew and Watkins (1998) observed that beliefs and attitudes towards mathematics are closely related to mathematics' achievement. There is an assumption that positive belief, attitude and motivation towards mathematics will lead to improved mathematical performance (Grootenboer 2003, Hannula 2004). However, the interrelationships of these variables and their causal effects on each other are still unclear.

In Mathematics Education, research on attitude has been motivated by the belief that something called 'attitude' plays a crucial role in learning mathematics (Neale 1969). Attitude can affect level of energy input, perseverance (Carroll 1963), time on tasks, standard of achievement (Webster and Fisher 2000) and engagement in an activity (Middleton and Toluk 1999). Wong (1992) investigated the relationship among mathematics achievement, affective variable and home background. He observed significant positive correlation between achievement in mathematics and attitude towards mathematics. Cheung (1998) examined the relationship between 'achievement in mathematics' and 'attitude towards mathematics' in Hong Kong. His subjects were 11-13 year olds. He described these ages as particularly important in the development of mathematical attitude. He observed a positive correlation between attitude and achievement in mathematics. Yee (2010) investigated mathematical attitude and achievement of 984 Junior College students in Singapore. His findings revealed positive correlation between achievement and attitudes.

Ma and Kishor (1997) conducted a meta-analysis to assess the relationship between attitudes toward mathematics (ATM) and achievement in mathematics (AIM). They summarized findings from 113 primary studies, involving 20227 students. Findings showed significant positive relationship between ATM and AIM, however, the difference, being small in magnitude, did not suggest much for educational practice.However, though these studies have shown positive correlations between attitude and achievement in mathematics, the goal of highlighting a connection between a 'positive' attitude and achievement has not been reached.

Motivation has been discussed under various terms in mathematics educations, for example, motivational orientation (Yates 2000), interest (Bikner-Ahsbahs 2003), and motivational beliefs (Kloosterman 2002). Middleton and Spanias (1999) viewed motivation as the reason individuals have for behaving in a given manner in a given situation. According to self-determination theory (Deci and Ryan 1985), motivation can be grouped into three main categories, namely 'amotivation', extrinsic motivation and intrinsic motivation. 'Amotivation' occurs when individuals feel that an activity has no

value, whereas intrinsic motivation causes students to engage in learning for their own sake. Extrinsic motivation, on the other hand, roots students' motivation in a need for rewards or to avoid punishment.

Research demonstrates a relatively consistent relationship between motivation and achievement in reading and mathematics (Broussard and Garrison 2004; Gottfried 1990). Yee (2010) observed that though students had positive attitudes toward mathematics, they lacked intrinsic motivation to do the subject. He noted that the relationship between extrinsic motivation and achievement was weak. On the other hand, he found a significant positive correlation between intrinsic motivation and achievement.Lange and Adler (1997) recognized that motivation contributed to the prediction of achievement over and above the effects of ability. Gottfried (1990) found a relationship between motivation and achievement, but she maintained that the causal relationship worked in the opposite direction. Reynolds (1991) found that although prior achievement was a dominant influence in later achievement other variables such as motivation and classroom context also contributed to later achievement.

Research evidences have shown that motivation led to engagement in academic tasks, which was related to achievement (Dweck 1986). Singh *et al.* (2002) suggested that doing homework and coming prepared for classes reflect engagement and motivation. They observed that motivation and academic engagement had reciprocal relationship. They claimed that motivation affected engagement in academic tasks and engagement further enhanced interest and motivation. In this study, motivation is measured as students' engagement in the school tasks.

Research related to 'perceived usefulness of mathematics' had been conducted mainly to determine whether it is related to students' choice of subjects at higher level of studies or for career prospect (Armstrong and Price 1982). However, some studies identified usefulness as important in predicting mathematics achievement and course plan (Armstrong 1985). Fennema and Sherman (1978) observed that students who received higher scores in tests of mathematics, at middle or high school, view mathematics as more useful than lower achieving students. A similar observation was made by Armstrong (1980) based on a large sample of twelfth graders. In a recent study on a sample of 1000 eight graders, Lianghuo *et al.* (2005) observed that Singapore students believed that mathematics was useful and important; but, only 64% of the students claimed that they would use mathematics a lot as adults. This suggested that some students did not see the potential usefulness of mathematics in their future life.

To identify the main predictors of mathematical achievement, Kiamanesh *et al.* (2004) investigated the effect of five variables (maths self efficacy, maths self concept, perceived usefulness of mathematics, maths anxiety and gender) using Regression Analysis and Path Analysis on a sample of 400 students. They observed that direct effect of 'perceived usefulness of mathematics' on the mathematics achievement was not significant.

Schunk (1991) observed that students were highly motivated in school

when they believed that what they were learning would be of value to them. Similarly, correlational studies revealed that students who believed that mathematics was useful and were confident in their mathematical ability had higher achievement (Armstrong 1980, Fennema and Shermann 1978). Kloostermann and Cougan (1994) suggested that beliefs influenced actions, resulting in more efforts, and hence in higher achievement in mathematics.

The literature suggests that affective variables are interrelated and are likely to affect academic achievement. The present study aims to clarify (using structural equation modeling) the direction and magnitude of the relationships between these variables (attitude, motivation, 'perceived usefulness of mathematics') and mathematics achievement at lower secondary level.No such studies have been conducted in Mauritius yet.

Method

This study is part of a larger study investigating student's mathematics achievement at grade 8 level in Mauritius. A mathematics test was prepared by the researcher and administered to around 915 students from 13 schools. The purpose of the mathematics test was to categorize the participants into three ability groups (low, average and high ability). The test contains questions from grade 7 syllabus. Prior to administration, the test was piloted on a group of nine grade 8 students from different schools and with different abilities. Post piloting, the test was finalized with some modifications and administered to the 915 students, during first term in 2011. The scripts were marked according to a marking scheme and the maximum score for the test is 70. The test was reliable with Cronbach Alpha greater than 0.8. Scores from this test together with those from the National Examination at grade 6 level were used as indicators for mathematics performance.

Data were also collected, through questionnaire, on level of motivation, mathematics attitude and perceived usefulness of mathematics with the aim to develop a model so as to assess their impact on student's mathematics performance. Again, the questionnaire was prepared by the researcher based on recent research studies. After eliminating students who were absent on either test or questionnaire administration and incomplete form, a sample of 775 candidates was retained.

A latent variable structural equation model was estimated in several steps using LISREL 9 computer program (MacCallum, Browne and Sugawara, 1996). The measurement part of the model (construct and indicators) was first estimated and then structural relationship was estimated. The program generates fit indices that enable the evaluation of the adequacy of the model in explaining the data. A final model was reach with all significant factor loadings. The direct and indirect effects of the variables are also presented and their implication on the teaching of mathematics is discussed.

Variables and Indicators

The variables together with their indices and coding are presented in Table 1. Three indicators were used to assess attitude, motivation and 'perceived usefulness of mathematics' and two for mathematics achievement.

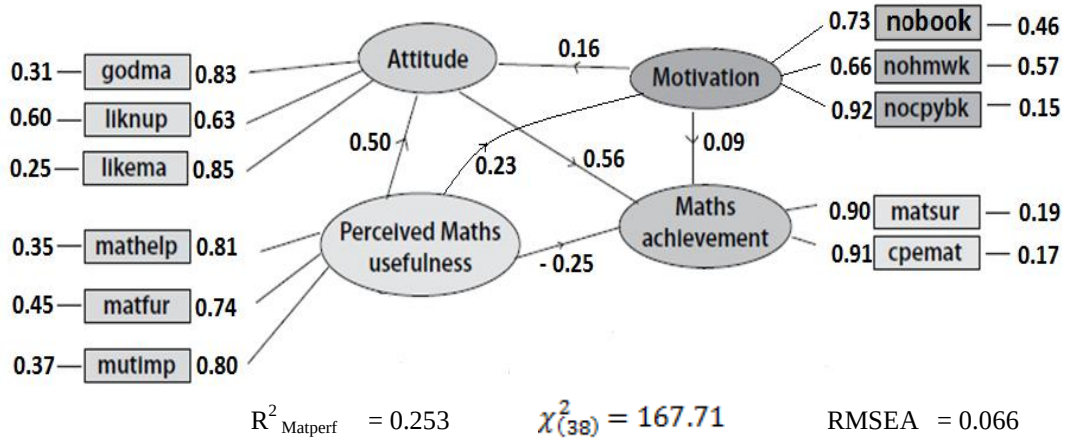
Table 1. *Questionnaire Items and Latent Variables*

Variables	Indicators
Attitude	godma - I am good at Maths liknup - I like doing number problems likema - I like maths *(For all item, 5=strongly agree to 1=strongly disagree)*
Perceived Usefulness of maths	mathelp - Knowing mathematics will help me earn a living matfur - I'll need mathematics for my future work mutimp- Maths is an important and necessary subject. *(For all item, 5=strongly agree to 1=strongly disagree)*
Motivation	nobook- How often come to class without book *(5=rarely to 1=daily)* nohmwk- How often come to class without homework *(5=rarely to 1=daily)* nocpybk - How often come to class without copybook *(5=rarely to 1=daily)*
Maths performance	cpemat- Certificate of Primary Education results *(6=A+ to 1=E)* matsur- Mathematics survey results *(7 = 61-70 to 1 = 1-10)*

Results

The resulting model is presented in Figure 1 where the values represent the standardized estimates. The model accounted for 25.3% of the variance in mathematics performance. The fits indices of the model were high indicating a well fitted model.

Figure 1. *Model Showing Effect of Affective Variables and SES on Maths Achievement*



The Root Mean Square Error of Approximation (RMSEA) being 0.066

suggests that the model is of reasonable fit (MacCallum, Browne and Sugawara, 1996). The standardized Root Mean Square Residual (standardized RMR) value 0.032 (< 0.05), the Goodness of Fit Index (GFI) is 0.965 and the Adjusted GFI is 0.939, being greater than 0.9, indicate acceptable fits (Joreskog and Sorborn, 1993). The Comparative Fit Index (CFI = 0.997) being close to 1 indicates good fit (Joreskog and Sorborn, 1993). The overall fit criteria shows that the model is satisfactory. Further, for the model, all indicator loadings are significant ($p < 0.05$) as indicated by t-values in excess of 1.96 in absolute terms. This provides validity evidence in favour of the indicators used to represent the construct of interest.

Table 2. *Composite Reliability for the Latent Variables*

Latent Variable	Composite reliability, ρ_c	Average Variance Extrated, ρ_v
Attitude	0.821	0.609
Motivation	0.819	0.606
Perceived usefulness of Maths	0.825	0.611
Maths Performance	0.900	0.820

Moreover, Table 2 shows that for each latent variable, the composite reliability (ρ_c) for is greater than 0.6 and the average variance extracted (ρ_v) is greater than 0.5. These signify that the indicators as a set (for each latent variable) provide reliable measurement of the construct. Overall, the assessment of the measurement part of the model reveal good evidence of validity and reliability for the use of most of the latent variables.

Table 3. *Direct, Indirect and Total Effect on Mathematics Achievement*

Independent variable	**Attitude**			**Motivation**	**Maths Achievement**		
	Direct	Indirect	Total	Total	Direct	Indirect	Total
P. Usefulness of Maths	0.497*	0.037*	0.534*	0.226*	-0.252*	0.319*	0.067*
Attitude	-	-	-	-	-	-	0.560*
Motivation	-	-	0.164*	-	0.091*	0.092*	0.183*

*p<0.05

Table 3 shows the effects among the different variables. For instance, it is found that attitude have strong direct influences on mathematics achievement. 'Perceived usefulness of mathematics' is found to have a strong influence on attitude, a low influence on motivation but a negative medium influence on mathematics achievement. However, due to indirect positive influence, 'Perceived usefulness of mathematics' has a weak positive impact on mathematics achievement. Motivation is found to have a direct low influence on mathematics achievement.

Conclusion

This study investigated the influence of affective variables (attitude, motivation and perceived usefulness of mathematics) on mathematics achievement of Mauritian students. It was observed that affective variables account for 25.3% of variances in mathematics performance. Attitude has strong positive direct effect on mathematics achievement. 'Perceived mathematics usefulness' has a strong positive effect on attitude, a positive effect on motivation but a negative influence on maths achievement. This suggests that 'perceiving mathematics as useful' does not necessarily enhance mathematics performance unless that perception triggers some positive attitude or motivation toward mathematics. This is partly in line with the findings of Kloostermann and Cougan (1994) who observed that beliefs influenced actions, resulting in more efforts, and hence in higher achievement in mathematics. On the other hand, those who do not act will not improve. Quite similar observation was made by Kiamanesh *et al.* (2004), that is, direct effect of 'perceived usefulness of mathematics' on the mathematics achievement was not significant. The findings of the present study suggest that teacher training program should address the issue of students' motivational and attitudinal problem. That is, the teaching of mathematics should include some elements that promote positive attitude and motivation towards mathematics. Moreover, the use and importance of mathematics should be highlighted in the teaching and learning process.

References

Armstrong, J. (1980). *Achievement and participation of women in mathematics: An overview*. Denver, CO: Education Commission of the States.

Armstrong, J.M. & Price, R.A. (1982). Correlates and predictors of women's mathematics participation. *Journal for Research in Mathematics Education*, 13, 99-109.

Armstrong, T. (1985). How real are learning disabilities? *Learning*, 14 (2), 44-47.

Banks, C.W., Mcquater, G.V. & Hubbard, J.L. (1978). Toward a reconceptualization in the socio-cognitive bases of achievement orientations in Blacks. *Review of Educational Research*, 28 (3), 381-397.

Bikner-Ahsbahs, A. (2003). A social extension of a psychological interest theory. *In:* N.A. Pateman, B.J. Dougherty & J. Zilliox, eds. *Proceedings of the 27th Conference of the International Group for the Psychology of Mathematics Education*. Honolulu: University of Hawai'i, 2, 97-104.

Broussard, S.C. & Garrison, M.E. (2004). The Relationship between Classroom Motivation and
Academic Achievement in Elementary School-Aged Children. *Family Consumer Sci. Res. J.* 33(2), 106-120.

Carroll, J. (1963). A model for school learning. *Teachers College Record*, 64, 723-733.

Cheung, C. (1998). Conceptions of success. Their correlates with pro-social orientation and behaviour in Chinese adolescents. *Journal of Adolescence*, 21 (1), 31-42.

Deci, E.L. & Ryan, R.M. (1985). *Intrinsic motivation and self-determination in human behavior*. New York, NY: Plenum Press.

Dossey, J.A., Mullis, I.V.S., Lindquist, M.M. & Chambers, D.L. (1988). *The mathematics report card: Are we measuring up? Trends and achievement based on the 1986 National Assessment.* Princeton, N.J.: Educational Testing.

Drew, P.Y. & Watkins, D. (1998). Affective variables, learning approaches and academic achievement: A Causal Modeling Investigation with Hong Kong Tertiary Students. *British Journal of Educational Psychology*, 68 (2), 173-188.

Dweck, C.S. (1986). Motivational processes affecting learning. *American Psychologist*, A1(10), 1040-1048.

Fennema, E. & Sherman, J. (1978). Sex-related differences in mathematics achievement and related factors: A further study. *Journal of Research in Mathematics Education*, 9, 189-203.

Gottfried, A.E. (1990). Academic intrinsic motivation in young elementary school children. *Journal of Educational Psychology*, 82, 525-538.

Grootenboer, P.J. (2003). The affective views of primary school children. *In* : N.A. Pateman, B.J. Dougherty & J. Zilliox, eds. *Navigating between theory and practice.* Honolulu, HI: PME, 3, 1-8.

Hannula, M.S. (2004). Regulation motivation in mathematics. Paper presented at the *10th International Congress on Mathematical Education*. TSG 24, Copenhagen, Denmark.

Joreskog, K.G. & Sorborn, D. (1993). LISREL 8, Structural equation modeling with the SIMPLIS command language, Chicago, Scientific Software International, 1993.

Kiamanesh, A.R., Hejazi, E. & Esfahani, Z.N. (2004). The Role of Math Self-Efficacy, Math Self-Concept, Perceived Usefulness of Mathematics and Math Anxiety in Math Achievement. *Proceedings of the 3rd International Biennial SELF Research Conference, Self-Concept, Motivation and Identity: Where to from here? Berlin, 4-7 July, 2004.*

Kloosterman, P. (2002). Beliefs about mathematics and mathematics learning in the secondary school: Measurement and implications for motivation. *In*: G.C. Leder, E. Pehkonen & G. Törner, eds. *Beliefs: A Hidden Variable in Mathematics Education*. Dordrecht: Kluwer, 247- 269.

Kloosterman, P. & Cougan, M.C. (1994). Students' beliefs about learning school mathematics. *Elementary School Journal*, 94, 375-388.

Lange, G.W. & Adler, F. (1997). Motivation and achievement in elementary children. *Paper presented at the biennial meeting of the Society for Research in Child Development, Washington, D.C.*

Leder, G.C. & Forgasz, H.J. (2006). Affect and mathematics education: PME perspectives. *In*: A. Gutiérrez & P. Boero, eds. *Handbook of research on the psychology of mathematics education: Past, present and future*. Rotterdam, The Netherlands: Sense Publishers, 403-427.

Lianghuo, F., Seng, Q.K., Yan, Z., Mei, Y.S., Pereira-Mendoza, L. & Yee, L.P. (2005). Assessing Singapore Student's Attitudes toward Mathematics Learning: Findings from a Survey of Lower Secondary Students. *Earcome 3*. Libraries Unlimited, Inc.

Ma, X. & Kishor, N. (1997). Assessing the Relationship between Attitude toward Mathematics and Achievement in Mathematics: A Meta-Analysis. *Journal for Research in Mathematics Education*, 28 (1), 26-47.

MacCallum, R.C., Browne, M.W., & Sugawara. (1996). Power analysis and

determination of sample size for covariance structure modeling, Psychological Methods, 1 (1996), 130-149.

Middleton, J.A. & Spanias, P.A. (1999). Motivation for Achievement in Mathematics: Findings, Generalizations, and Criticism of the Research. *Journal for Research in Mathematics Education*, 30, 65-88.

Middleton, J.A. & Toluk, Z. (1999). First steps in the development of an adaptive, decision-making theory of motivation. *Educational Psychologist*, 34 (2), 99–112.

Neale, D.C. (1969). The role of attitudes in learning mathematics. *Arithmetic Teacher*, 16, 631-640.

Reynolds, A. J. (1991). The middle schooling process: Influences on science and mathematics achievement from the longitudinal study of American youth. *Adolescence*, 26, 132-157.

Schuck, S. & Grootenboer, P.J. (2004). Affective issues in mathematics education. *In*: B. Perry, C. Diezmann & G. Anthony, eds. *Review of mathematics education in Australasia 2000-2003*. Flaxton, QLD: Post Pressed, 53-74.

Schunk, D.H. (1991). Self-efficacy and academic motivation. *Educ. Psychol.* 26, 207-231.

Singh, K., Granville, M. & Dika, S. (2002). Mathematics and science achievement: Effects of motivation, interest, and academic engagement. *Journal of Educational Research*, 95 (6), 323-332.

Webster, B.J. & Fisher, D.L. (2000). Accounting for Variation in Science and Mathematics Achievement: A Multilevel Analysis of Australian Data. Third International Mathematics and Science Study (TIMSS). *School Effectiveness and School Improvement*, 11 (3), 339-360.

Wong, N.Y. (1992). The relationship among mathematics achievement, affective variables and home background. *Mathematics Education Research Journal*, 4, 32-42.

Yates, S.M. (2000). Student optimism, pessimism, motivation and achievement in mathematics: a longitudinal study. *In:* T. Nakahara & M. Koyama, eds. *Proceedings of the 24th Conference of the International Group for the Psychology of Mathematics Education*. Japan: Hiroshima University, 4, 297-304.

Yee, L.S. (2010). Mathematics Attitudes and Achievement of Junior College Students in Singapore. *In:* L. Sparrow, B. Kissane, & C. Hurst, eds. Shaping the Future of Mathematics education: *Proceedings of the 33rd Annual Conference of Mathematics Education Research Group of Australasia*. Freemantle: MERGA.