Analyzing the Relationship Between Self-Confidence in Mathematics and Students' Characteristics Using Multinomial Logistic Regression

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Abstract

This study investigates the relationship between self-confidence and achievement among Malaysian students using multinomial logistic regression and the data are from TIMSS 2007. Although, in general, Malaysian students had low self-confidence in learning mathematics, their performance in mathematics at the international level is higher as compared to some countries with high level of self-confidence. This study also found that, besides mathematics achievement, there are four other factors that separate the level of self-confidence among Malaysian students. These factors are gender of students, students' aspiration, use of computer for school work, having teachers who want students to do their best.

Keywords: *self-confidence, students' characteristics, multinomial logistic regression, attitude, achievement.*

Introduction

Several studies (Mettas et al, 2006; Papanastasiou, 2002) illustrate positive relationship between attitudes and achievements. The belief that positive attitude might lead to positive achievement is widespread. In contrast, there are other studies that revealed that attitudes and beliefs were not associated with mathematics achievement (Fraser & Butts, 1982). In fact, Papanastasiau (2000) stated that attitudes and beliefs cannot be used to predict mathematics achievement. Other researchers also believed that the relationship between attitudes toward mathematics and achievement as one of a reciprocal influence.

Student attitudes toward mathematics appear to be shaped by factors such as teachers and teaching characteristics (Dossey, 1992), learning and classroom environment (Schibeci & Riley, 1983; Martin, 1996), home environment (Martin, 1996; Hanson & Ginsburg, 1988; Kenschaft, 1991), achievement (Fraser & Butts, 1982), gender of students (Kaisser-Messmer, 1993), level of studies and language used at home (Van Damme et al., 2004; Cai, Moyer & Wang, 1997; Schreiber, 2002).

The aim of this paper is to investigate the relationship between attitudes and

achievement. Since many studies were concentrating on finding the effect of attitudes on achievement, this study will investigate the reverse, taking into account students' characteristics. However, this study is limited to investigating only self-confidence in learning mathematics as one component of attitudes toward mathematics. At the same time, we also wanted to find out the association between each of the students' characteristics and self-confidence in learning mathematics among the eighth grade students in Malaysia.

Methodology

This study utilises data from TIMSS2007 Malaysian student database which are available from http://timss.bc.edu/TIMSS2007/. The method of data collection and full description of the variables are illustrated in details by Olson, Martin & Mullis (2008). TIMSS was designed to provide trends in Grade 8 mathematics and science achievement in an international context involving participation of countries, including Malaysia (Martin et al., 2008).

TIMSS2007 had created an Index of Student' Self-Confidence in Learning Mathematics (SCM) to investigate how students think of their abilities in mathematics. This index is formed based on responses to four statements about their mathematics ability: 'I usually do well in mathematics', 'Mathematics is harder for me than for many of my classmates', 'I am just not good at mathematics', and 'I learn things quickly in mathematics'. The responses to these statements are agreed a lot, agreed a little, disagreed a little or disagreed a lot. The response categories for the middle two statements were reversed in constructing the index. The high level of the index indicated on average, students agreed a little or a lot with all four statements, while the low level of the index indicated students disagreed a little or a lot. All other response combinations are assigned to the medium level of the index.

This index is ordinal in nature and hence the most suitable method to analyze these data is the ordinal regression analysis. Unfortunately, the parallel regression assumption is frequently violated, hence Long & Freese (2006) suggested that multinomial models for nominal outcomes should be used as an alternative when this happens. The disadvantage of using multinomial logistic regression in analyzing ordinal data is that the power is lost but it has less stringent assumption.

The variables selected for the studies are those in the student data base. Naturally students' high level of self-confidence is associated with students' achievements in the past. However, since TIMSS 2007 did not collect such scores, the current achievement is used to represent the past achievement. This study has also included age of students as one of the variables to explain self-confidence in learning mathematics. Although these students are at the same level of study, there will be a slight variation in the age of the students. Because the

school starting age is the same for all students, the variation in age may have been due to students from national-type Chinese and Tamil primary schools are required to spend one year in *Remove Class* before entering national schools for secondary education. *Remove Class* is a transition year that enables students to acquire sufficient proficiency in the national language.

Home environment in this study is represented by number of books in home and parents' highest level of education and teachers and teaching characteristics are represented by students' perception that teachers want them to do their best and frequency of mathematics homework given by the teachers. On the other hand, the use of computers for school work can be part of the learning and classroom environment. Besides the above variables, we have also included students' educational aspiration since we believe that if a student has high aspiration, he or she will do well in his or her study.

The data in this study are analyzed using SPSS 11.0. The likelihood ratio test is used in significance testing. After investigating the coefficients and the Wald test, some of the categories were collapsed.

Finding and Discussion

There were 150 schools in Malaysia involved in TIMSS2007 with a total of 4466 students in the eighth grade. It is interesting to note that Malaysian students only had considerable self-confidence in their mathematics ability with around 28 percent at the high level of index, around 50 percent at the medium level and the rest were at the low level. The percentage of high level of index is significantly lower by 11% than the percentage of the same category in 2003. Eventually, the percentages of the other two categories increase as a result of the decrease of the high level of index. According to the report by Martin et al (2008), not only Malaysia among the three countries with reduced percentage of high level of index but it also had the largest reduction in percentage and consequently Malaysia is listed under countries with the lowest percentage of self-confidence. Table 1 also shows that there was positive association between self-confidence in learning mathematics and mathematics achievement at the eighth grade. Achievement was highest among students at the high level of the mathematics self-confidence index and with such a significant reduction in percentage of high level of index among Malaysian students in 2007, it could be one of the reasons why Malaysia has plunged from the tenth place in 2003 to twentieth in 2007 with a drop of 34 score points and an average of 474 which is below the international average of 500.

Table 2 describes the variables used in the study and their distributions. As mentioned earlier, the average mathematics score for Malaysian students is around 474 with a minimum score of 178 and a maximum of 687 giving a range of almost 510 points. Since the study only

involved eighth graders, it is expected that the mean age of the students is around 14 years old with a minimum age of 13.5 years and a maximum is of 16.3 years. The distribution of the gender of the students is almost equal with almost 53% of the students are girls and the rest are boys.

[INSERT TABLE 1]

There were 10 covariates included in this study and these covariates are described in Table 2. From the likelihood ratio tests of individual parameters, we found that the models without age, speak language of test in home, number of books in home, parents' highest education level and frequency of mathematics homework are not significantly different from the final model and therefore they should be dropped based on preference for the more parsimonious reduced model. Hence there are only five variables included in the final model and upon investigating the coefficients and the Wald tests, we have re-group the categories into two for each polytomous variable. Students' educational aspirations is divided into upper secondary education and above, and lower secondary education and below with the latter as the reference group. In the mean while, use of computer for school work is categorized as frequent or infrequent use of the computer. Frequent use includes the use of computer three or four times a week or everyday. On the other hand, infrequent use is defined as less than once a week or never. The reference group is infrequent use of computer. Lastly, teacher wants students to do their best is categorized as agree a lot or others with others as reference group.

[INSERT TABLE 2]

The results of fitting mathematics achievement, gender, students' educational aspiration, use of computer from school work and teachers want students to do their best are shown in Table 3. This model has 3875 valid cases and 5 independent variables, giving a ratio of 775. This ratio is greater than the minimum ratio of at least 10 to 1 and therefore, the requirement for a minimum ratio of cases to independent variables was satisfied. The model is significant with a chi-square of 705.706, $p < 0.001$. None of the independent variables in this analysis had a standard error larger than 2.0, indicating that no numerical problem, such as multicollinearity among the independent variables, exits. The Nagelkerke's R^2 is 0.19, indicating that the association between the independent variables and self-confidence in learning mathematics is rather low. However, this situation is expected in any social science research. Table 4 shows that this model has an accuracy rate of 54.9% (Table 4). While this model can be used to explain those in the medium level correctly by 82%, but it can only correctly classify those in high level by about 50% and cannot be used to classify those in the low level.

[INSERT TABLE 3]

[INSERT TABLE 4]

Since the odds ratio of mathematics score is close to 1 for both high and medium level of self-confidence in learning mathematics, we can conclude that mathematics score did not have a strong association with the level of self-confidence. From Table 4, we can conclude that a 10 point increase in mathematics score increases by 15% and 2% the odds of being in high and medium level, respectively, rather than in the low level. The odds of being in medium level rather than low level of self-confidence in learning mathematics is increased by a factor of 1.24 by being male rather than female, controlling for other variables in the model. Unfortunately, we cannot make a corresponding statement about variables in the model. In other words, boys are more likely than girls to be in medium level than in the low level.

Students' educational aspiration is not significantly related to the odds of being in the medium level compared being in the low level. However, it is highly significant for high level of index where the odds ratio for those who aspire to complete upper secondary level of study and above is 1.694. It is also interesting to note that regular use of computer for school work is positively associated with higher level of self-confidence. The odds for high level is 1.807 and the odds for medium level is 1.445. Lastly, the results in Table 4 also indicate the effect of teacher is not the same for high and medium level of self-confidence in learning mathematics. While the odds of being in the high than low level is increased by a factor of 1.249 when the teachers want students to do their best, the odds of being in the medium than low has decreased.

Conclusion

From the TIMSS report (Martin et al, 2008), we found that although Malaysia had amongst the lowest percentage of students in the high level of self-confidence, their performance in mathematics was better as compared with other countries with high percentage of student in the high level. We also found that, among Malaysian students, mathematics achievement, students' aspiration and use of computer for school work are associated to higher level of self-confidence. However, although mathematics achievement is significant, the strength of the association is rather weak. We also found that males are more likely than females to be in medium level than in the low level and sex does not matter for those in the high level of self-confidence in learning mathematics. It is also interesting to note that the effect of teachers can only be found in students at the higher level of self-confidence but not in the medium level.

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Table 1: Percentage Distribution and Differences in Percentage of Index of Students' Self-Confidence in Learning Mathematics

Index	2007 %	Average Achievement	2003 %	Average Achievement	% change
High SCM	27 (1.4)	521 (5.3)	39 (1.2)	546 (4.2)	-11 (1.8)
Medium SCM	50 (1.2)	458 (5.1)	45 (1.0)	490 (3.7)	5 (1.5)
Low SCM	23 (0.8)	453 (4.5)	16 (0.7)	471 (4.4)	6 (1.0)

Note: Results are rounded to the nearest whole number. () Standard errors appear in parentheses.

Source: Exhibit 4.10 in TIMSS 2007 International Mathematics Reports and Exhibit 4.9 in TIMSS 2003International Mathematics Reports.

Table 2: List of Covariates Considered in the Study

No.	Variable	Name	No	Variable	Name
1	**Mathematics Achievement**	MATH	7	**Student's Educational Aspirations**	ASP
2	**Age of Student**	AGE		1 = I do not know	
3	**Gender of the Students**	GENDER		2 = FINISH ISCED 3	
	1 = boy			3 = FINISH ISCED 4	
	2 = girl			4 = FINISH ISCED 5B	
4	**Speak the Language of the Test in Home**	SPEAK		5 = FINISH ISCED 5A, FIRST DEGREE	
	1 = never			6 = BEYOND ISCED 5A	
	2 = sometimes		8	**How Often Use Computer for Schoolwork**	COMP
	3 = almost always			1 = every day	
	4 = always			2 = at least once a week	
5	**Parents' Highest Education Level**			3 = once or twice a month	
	1 = Do not know			4 = a few times a year	
	2 = Less than secondary education			5 = never	
	3 = Completed lower secondary education		9	**Teachers Want Students to do Their Best**	BEST
	4 = Completed upper secondary education			1 = disagree	
	5 = Completed post secondary but not university			2 = Agree a little	
	6 = University degree			3 = Agree a lot	
6	**No. of Books in the Home**	BOOK	10	**Frequency of**	HWK

	Mathematics Homework
1 = Over 100	1 = less than once a week or never
2 = 26-100	2 = 3 or 4 times a week
3 = 11-25	3 = Everyday
4 = 0-10	

Note: The last category is used as the default reference category in SPSS

Table 4: Classification table

Observed	Predicted HIGH	MEDIUM	LOW	Percentage correct
HIGH	549	569	0	49.1%
MEDIUM	327	1577	0	82.8%
LOW	76	777	0	0.0%
Overall Percentage	26.6%	75.4%	0.0%	54.9%

Table 3: Parameter Estimates

Group	Variables	Categories	B	SE	Wald	df	p-value	Exp(B)	95% Confidence interval for Exp(B)
high	Intercept		-7.469	0.392	362.130	1	<0.001		
	Math		0.014	0.001	365.394	1	<0.001	1.014	(1.013, 1.016)
	Gender	Boy	0.102	0.099	1.062	1	0.303	1.107	(0.912, 1.343)
		Girl	0	.	.	0	.	.	.
	Asp	Upper Secondary School and above	0.527	0.129	16.680	1	<0.001	1.694	(1.316, 2.182)
		Lower Secondary Education and lower	0	.	.	0	.	.	.
	Comp	Frequent use	0.592	0.129	20.944	1	<0.001	1.807	(1.402, 2.328)
		Infrequent use	0	.	.	0	.	.	.
	Best	Agree a lot	0.222	0.112	3.904	1	0.048	1.249	(1.002, 1.557)
		Agree a little and disagree	0	.	.	0	.	.	.
medium	Intercept		-0.086	0.291	0.086	1	0.769		
	Math		0.002	0.001	8.205	1	0.004	1.002	(1.001, 1.003)
	Gender	Boy	0.215	0.084	6.590	1	0.010	1.240	(1.052, 1.462)
		Girl	0	.	.	0	.	.	.
	Asp	Upper Secondary School and above	0.120	0.098	1.502	1	0.220	1.127	(0.931, 1.365)
		Lower Secondary Education and lower	0	.	.	0	.	.	.
	Comp	Frequent use	0.368	0.113	10.648	1	0.001	1.445	(1.158, 1.802)
		Infrequent Use	0	.	.	0	.	.	.
	Best	Agree a lot	-0.222	0.094	5.621	1	0.018	.801	(0.667, 0.962)
		Agree a little and disagree	0	.	.	0	.	.	.