Understanding the Gap in Mathematics Achievement of Malaysian Students

NOOR AZINA ISMAIL
University of Malaya, Kuala Lumpur, Malaysia

ABSTRACT. Of 46 countries that participated in the Trends in International Mathematics and Science Study in 2003 (I. V. S. Mullis, M. O. Martin, E. J. Gonzalez, & S. J. Chrostowski, 2004), Malaysia was ranked 10th in international scores of mathematics achievement for 8th-grade students. The present author aimed to examine the importance of students' home backgrounds, resources for learning, activities, and attitudes toward learning mathematics in accounting for high student achievement in mathematics. Using multiple logistic regression analysis, the author found that having self-confidence in learning mathematics, having a large number of books at home, regularly using computers, and being non-Malay have a high positive association with mathematics achievement among Malaysian students.

Keywords: achievement, logistic regression, Trends in Internal Mathematics and Science Study

Malaysia is highly committed to providing education for all, regardless of ethnic group, gender, and marital or economic status, especially at the primary and secondary school levels. Malaysia's educational system is a highly centralized system by which the Ministry of Education (MOE) formulates policy guidelines; translates policies into plans, programs, projects, and activities; develops curriculum syllabi; and coordinates and implements national examinations. Children enter primary school at 6 years of age or older and, after completing 6 years of primary school, proceed to the lower secondary level for 3 years. This level is followed by 2 years of upper secondary school. On completion of the secondary level, they may proceed to the preuniversity program.

Despite wide access to education and the MOE's full control of the curriculum, the Malaysian average mathematics score in the Trends in International Mathematics and Science Study (TIMSS) was still less than that of some other Asian countries, such as Singapore, the Republic of Korea, Hong Kong, Chinese Taipei, and Japan (Mullis, Martin, Gonzalez, & Chrostowski, 2004). Although Malaysia ranked 10th, its average mathematics score was not significantly higher than those of the 10 countries below it. Nevertheless, Malaysian performance was well above expectations given its human development index (HDI). Countries with a similar HDI (e.g., the Russian Federation, Macedonia, Bulgaria, Latvia, Lithuania, Chile) obtained the same average mathematics scores or lower (Mullis et al.).

Cross-country correlation shows a strong positive relation between mathematics achievement and HDI ($r = .722$, $p < .001$). The result from a simple linear regression analysis also implied that HDI accounted for more than 52% of the variation in mathematics achievement internationally. Other characteristics that may be considered are student and school characteristics as well as teaching quality.

The student effectiveness literature refers to several factors that may be helpful in understanding why some students attain higher performance levels than do others. Reasons include students' personal and home backgrounds, resources for learning, time spent out of school in studying or doing homework in school subjects, self-confidence in learning mathematics, motivation to learn mathematics, and perceptions of being safe in school.

In the present study, I aimed to investigate which student characteristics or factors separate the high and low achievers among Malaysian students. At the same time, I wanted to find out the association between each of these characteristics and mathematics achievement to help the Malaysian policymakers to consider what action can be taken to improve mathematics achievement among low achievers.

A report on TIMSS (Mullis et al., 2004) used univariate analyses to investigate the relations between the aforementioned factors and mathematics achievement. In the present study, I used a multivariate logistic regression to investigate the relations between the aforementioned variables and the probability of a student's performing better than the international average. In other words, I was interested in investigating the characteristics of an

Address correspondence to Noor Azina Ismail, Faculty of Economics and Administration, University of Malaya, 50603 Kuala Lumpur, Malaysia. (E-mail: nazina@um.edu.my)

eighth-grade Malaysian student who performs well above the international average in mathematics.

Because most of the factors are categorical variables, the use of linear regression is not suitable because it is difficult to satisfy the assumptions on which the model is based: normal distribution and homoscedasticity of the residuals. In contrast, the statistical model of logistic regression is more flexible and does not assume the relation between the independent and dependent variables to be linear. However, because mathematics achievement is continuous, it has to be dichotomized so that it can be modeled by using logistic regression.

To my knowledge, the present study is the first to use this technique to analyze TIMSS data. The same technique can be used for analyses of mathematical achievement in other countries.

Review of Literature

A large body of literature has discussed factors associated with student achievements. Coleman et al. (1966) suggested that educational achievement is determined by factors beyond the control of educators and depends exclusively on the home environment and peer group. Although I acknowledge that other researchers (Hanushek, 1986, 1989; Hedges, Laine, & Greenwald, 1994; Jacques & Brorsen, 2002; Summers & Wolfe, 1977) have found that school input and teachers do matter, in the present study, I focused on factors related to home backgrounds, students' activities and attitudes, and data collected by TIMSS.

One of the factors commonly investigated is gender differences. Previous studies (Beaton et al., 1996; Fennema & Sherman, 1977; Janson, 1996; Mullis et al., 2000) have shown that male students outperformed female students in mathematics at junior high and high school levels. Furthermore, there were significant differences in attitudes toward mathematics between the two genders. A study by Zhang and Manon (2000) recognized that gender alone may not explain significant differences in performance. The results of TIMSS showed no difference in the average mathematical achievement between eighth-grade male and female students across all countries.

In 2003, TIMSS focused on just a few variables to present students' backgrounds. These variables were level of parental education, which refers to the highest educational level of either parent; student's educational aspirations; speaking the language of the test at home; having a range of study aids in the home; and computer use at home and at school. There is abundant evidence that students' achievements are related to home background factors (Beaton et al., 1996; Cooper & Cohn, 1997; Marjoribanks, 2002; Mullis et al., 2000; O'Connor, Miranda, & Beasley, 1999).

According to a report of TIMSS (Mullis et al., 2004), a higher level of parental education was associated with higher student achievement in mathematics. It was also found that students had high expectations of university education, and, in particular, those who had a parent with a university education showed higher achievement. Furthermore, students expecting to finish university showed substantially greater average achievement in mathematics than did those without university expectations. Unlike other countries in the TIMSS study, Malaysian students from homes in which the language of the test was always or almost always spoken showed lower average achievement than did those who spoke it less frequently. TIMSS also found that students with literacy resources such as books and study aids, a computer, and a study desk or table showed higher achievement than did those from less advantaged backgrounds.

Besides students' backgrounds, students' activities and attitudes were also investigated in TIMSS. These variables included time spent on homework, students' self-confidence in learning mathematics, and students' motivation to learn mathematics, which was represented in terms of students' valuing of mathematics. It is believed that students' motivation to learn mathematics can be affected by the extent to which students find the subject enjoyable, place value on the subject, and think it is important for success in school and future career aspirations (Mettas, Karmiotis, & Christoforou, 2006; Middleton & Spanias, 1999; Mullis et al., 2004).

The relation between students' perceptions of being safe in school and achievements was also investigated in the TIMSS report. In general, students who had better perceptions of being safe in school scored higher than did those who had worse perceptions.

Method

Data Analysis

In the present study, I used TIMSS data collected by the International Association for Evaluation of Educational Achievement (IEA) in 2003 (Mullis et al., 2004). The focus of my analysis was on the mathematics achievement of eighth-grade students in Malaysia. The variables that I investigated were limited to those collected from the students, although TIMSS did collect information from teachers and principals.

In the present study, I used level of parental education and number of books in the home to represent the family's socioeconomic status (SES). Access to and use of computers could not be proxies for SES because they represented the use of computers in the home and in school, as well as in other places. A study desk is affordable in Malaysia and, therefore, was also not used as a proxy for SES.

Data were analyzed using SPSS (Version 11.0) statistical software. I used descriptive statistics, such as frequencies and percentages, to summarize the sample's characteristics. I recategorized some of the categories of variables into a smaller number of groups for easy interpretation in the analysis. I recorded categorical data as frequencies and continuous data as means. I also tested the assumption of linearity for continuous data. At that stage, I addressed the appropriate categories for discrete variables.

The process of selecting variables to be included in the multivariate analysis began with a careful univariate analysis of each variable. I considered any variable for which the univariate test gave a *p* value of less than .25 as a candidate for the multivariate model. I based the screening criteria of .25 for variable selection on work by Bendel and Afifi (1977). Once I had selected the variables, I evaluated a model containing all the selected variables. I also verified the importance of each variable included in the model by examining the Wald statistic for each variable and comparing the new model with the old or larger model by using the likelihood ratio test. I then used a model without nonsignificant variables for interpretation.

Results

Data Description

Participants were 5,314 students from a total of 152 schools in Malaysia who had been involved in TIMSS 2003. Table 1 shows that almost 70% of the Malaysian students scored higher than the international average. This percentage was quite high, and Malaysia was ranked 10th in the international scores of mathematical achievement. Of the 5,314 students participating in the study, approximately 58% were female and 42% were male. The average age of the sampled students at the time of testing was 14.340 years (*SD* = 0.372 years), with a minimum age of 12.8 years and a maximum age of 15.8 years. Because the school starting age is the same for all students, the large variation in age may have been because of two possible causes. First, from 1996 to 2000, students who excelled in the Penilaian Tahap Satu (translation: Level One Evaluation; PTS; Education for All, 2000), which was administered to Year 3 students, were able to skip Year 4 and attend Year 5 instead. Therefore, some of the eighth-grade students in the TIMSS may have belonged to this group, and hence their ages would have been younger than those of the other students. Second, students from national-type Chinese and Tamil primary schools are required to spend 1 year in Remove Class before entering national schools for secondary education. *Remove Class* is a transition year that enables these students to acquire sufficient proficiency in the national language.

Table 1 shows that around 69% of the students reported parental education of secondary level or lower. Hence, researchers can conclude that in Malaysia, the percentage of parents with a university education is still low in comparison with other countries.

In most countries surveyed by TIMSS, students had high expectations of completing university education. The situation was the same in Malaysia, where approximately 65% of students aspired to finish university, whereas approximately 35% either did not expect to complete university or did not have aspirations to finish university.

Table 1 also shows that around one third of students sometimes or never spoke the language of the test at home. Although only slightly less than half of the students had more than one bookcase of books and slightly more than half had access to computers, the majority of students possessed a study desk. In general, students felt safe in school. Exactly 33% had high indexes of time spent on mathematics homework, approximately 39% had high indexes of self-confidence in learning mathematics, and the majority had high indexes of valuing mathematics.

Analysis

From the results of the univariate analyses, I found that there was evidence that each of the variables had some association ($p < .25$) with the outcome of obtaining a mathematics score that was above the international average. Hence, I began the multivariate model with all variables. The final model, after dropping the insignificant variables, is given in Table 2. From the table, researchers can conclude that there was no association between the ages of students and scoring above the international average in mathematics. This result may be largely due to the lack of variability in this measure: All the students had basically the same age. Although having a study desk was significant at the individual level, its effect disappeared when other variables were taken into account. All other factors (being female, having parents with a higher level of education, having aspirations to finish university education, sometimes or never speaking the language of the test at home, having one or more bookcases of books at home, regularly using computers, having a high index of students' perception of being safe in school, having self-confidence in learning mathematics, placing value on mathematics, and spending time on mathematics homework) were positively associated with high mathematics achievement at the international level.

Although most of the variables I considered had a significant relation with mathematics achievement, only language spoken at home, number of books in the home, computer use, and self-confidence in learning mathematics had a high association with mathematics achievement among Malaysian students. Those who sometimes or never spoke the language of the test at home and had at least one bookcase of books at home were almost twice as likely to score above the international average, whereas those who used a computer regularly and had high self-confidence in learning mathematics were 2.3 and 3.5 times more likely to score above the international average, respectively.

Conclusion and Recommendations

There is no doubt that almost all the factors considered in the present study were associated with the chance

TABLE 1. Student Characteristics

Variable name	Variable abbreviation	*n*	%	M	*SD*	Min	Max
Mathematics achievement	MATH	5,314					
Above international average (1)			69.5				
Below international average (0)			30.5				
Gender	GENDER	5,314					
Female (1)			57.8				
Male (0)			42.2				
Age of student		5,314		14.340	0.372	12.83	15.75
Parents' highest level of education	PHE	4,638					
Finished post-secondary vocational/ technical education or above (1)			30.7				
Finished upper secondary schooling or below (0)			69.3				
Student's educational aspirations	ASP	5,314					
Finish university (1)			64.5				
Not finish university or do not know (0)			35.5				
Speak the language of the test at home	SPEAK	5,311					
Sometimes or never (1)			34.8				
Almost always or always (0)			65.2				
Number of books in the home	BOOK	5,309					
One bookcase (26–100 books) or above (1)			42.7				
One shelf (11–25 books) or below (0)			57.3				
Possess study desk in the home	DESK	5,298					
Yes (1)			87.6				
No (0)			12.4				
Availability of computer	COMP	5,196					
Regular use of computers (use at home, at school, or both) (1)			51.6				
Irregular use of computers (use only in school or other places or do not use at all) (0)			48.4				
Index of student perception of being safe in school	SPBSS	5,314					
High (1)			51.7				
Medium/low (0)			48.3				
Index of time spent on math homework	TMH	5,258					
High (1)			33.0				
Medium/low (0)			67.0				
Index of self-confidence in learning mathematics	SCM	5,293					
High (1)			38.5				
Medium/low (0)			61.5				
Index of students valuing math	SVM	5,292					
High (1)			77.9				
Medium/low (0)			22.1				

Note. Coding of variable attributes is indicated by number in parentheses (1, 0). Min = minimum; Max = maximum.

of scoring higher than the international average. Nevertheless, the four main factors that separate high and low achievers among Malaysian students in mathematics achievement were self-confidence in learning mathematics, regular use of computers, sometimes or never speaking the language of the test at home, and having at least one bookcase of books at home.

Students with a high index of self-confidence did well compared with those with a medium or low index, which may have offset their disadvantaged backgrounds. Unfortunately, only around 39% of these students had a high index, and more than 86% of students with a high index of self-confidence scored higher than the international average. Malaysian teachers should promote a positive attitude toward mathematics, thus improving their students' self-confidence in learning the subject using classroom practice and good teaching strategies.

Another area in which Malaysia can improve mathematics achievement is through the frequent use of computers by Malaysian students. Although I could not determine whether the participants used computers for learning mathematics or for other purposes, from the findings of the present study, I am sure that students who used computers regularly were more likely to score above the international average. The government of Malaysia has taken various measures to increase the accessibility of computers to its citizens. These measures include granting tax rebates of RM400 every 5 years for the purchase of computers, providing loans

TABLE 2. Final Model Containing Significant Main Effects

Variables	Coefficient *B*	*SE B*	*p*	Exponent *B*	CI
Constant	–1.210	.110	< .001	0.298	
GENDER	0.178	.076	.018	1.195	1.030, 1.386
PHE	0.264	.093	.005	1.302	1.084, 1.563
ASP	0.398	.079	< .001	1.489	1.275, 1.738
SPEAK	0.669	.083	< .001	1.953	1.659, 2.296
BOOK	0.549	.082	< .001	1.732	1.474, 2.034
COMP	0.816	.080	< .001	2.262	1.933, 2.647
SPBSS	0.378	.074	< .001	1.459	1.261, 1.687
TMH	0.326	.081	< .001	1.385	1.182, 1.623
SCM	1.250	.088	< .001	3.491	2.940, 4.145
SVM	0.315	.088	< .001	1.370	1.152, 1.629

Note. –2 log likelihood = 4435.936. CI = 95% confidence interval; PHE = parents' highest level of education; ASP = student's educational aspirations; SPEAK = speak the language of the test at home; BOOK = number of books in the home; COMP = availability of computer; SPBSS = index of student perception of being safe in school; TMH = index of time spent on math homework; SCM = index of self-confidence in learning mathematics; SVM = index of students valuing math.

to government employees for the purchase of computers during their tenures of service, and allowing contributors to the Employee Providence Fund to withdraw funds to purchase computers for their children (Malaysia Budget, 2001). Despite this encouragement by the government, only 52% of the students in the present study used computers at home and at school, and the remainder used computers only at places other than home and school, or did not use computers at all. The international average for using computers at home and at school was 63%, and so Malaysia's score fell considerably below the international average. Countries like Chinese Taipei, Australia, England, the Netherlands, Scotland, Hong Kong, the United States, and Singapore were among the top 10 countries in percentage of students who used computers at home and at school.

Although some of these countries were ranked lower than Malaysia in terms of overall achievement in mathematics, students using computers at home and at school remains an area where Malaysia could improve its position in the world because, among Malaysian students, those who regularly used computers had a higher mathematics achievement than those who did not (see Table 2). Parents in Malaysia should be made aware of the usefulness of computers in improving mathematics achievement to encourage them to take full advantage of government provisions enabling them to purchase computers for their children at home. However, schools should maximize the use of computers supplied by the government in their mathematics teaching and learning so that students in rural areas can use computers more in school, because most of these parents cannot afford to purchase a computer for their home.

The number of books at home was also associated with higher mathematics achievement. Parents should be encouraged to purchase more books, especially those related to learning mathematics. As mentioned earlier, this variable is also a proxy of SES. In addition, schools or local governments should furnish their libraries with more recent publications and materials to encourage students to study, especially in rural areas.

The present study also showed that students who spoke the language of the test at home were less likely to score above the international average. The language of the test used for TIMSS in Malaysia is Bahasa Malaysia. As indicated by Noor Azina and Halimah (2007), this finding seems to suggest that language is not crucial in mathematics learning. Those who do not speak Bahasa Malaysia at home understand the language because it is the national language of Malaysia. Furthermore, this finding also suggests that other ethnic groups, such as Chinese and Indian, had higher scores than their Malay counterparts in the present study. Students from ethnic Chinese and Indian families normally communicate in their own languages at home. It would be interesting to see the effect of this variable in the next TIMSS because Malaysia began implementing the teaching of mathematics in English in 2003. A more thorough study should be carried out to investigate the weakness of Malay students in mathematics.

In conclusion, in the present study, I focused on a set of variables that may help to reduce the gap between high and low achievers. Consequently, I suggest steps to move Malaysia to the forefront of mathematics education. A different set of variables may be important in other countries involved in TIMSS, and that issue is beyond the scope of the present study.

Limitation of the Study

One of the limitations of the present study is that I only considered factors that were related to student characteristics. I did not consider teaching quality and school characteristics in trying to understand the gap in mathematics achievement among Malaysian students. Future researchers should take these variables into account and use multilevel modeling because teachers' and schools' effectiveness represent different levels of hierarchy compared with data collected on students.

Furthermore, the original form of the mathematics score is continuous but dichotomized so that it can be modeled by using logistic regression. During this process, information is lost, and the regression could eventually yield different results depending on the cutting points selected.

Last, I used level of parental education and number of books in the home as a proxy measure of SES rather than the more direct measure. However, in the present study, I used only information collected in TIMSS and, because the direct measure of SES was not available, the aforementioned variables were used as a proxy of SES.

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Among Those Present

BRENDA TRACY (brenda.tracy@norris160.org) is a school principal in the Norris School District in Firth, Nebraska. Her current research interests include academic strategy instruction for children at risk for learning difficulties. **ROBERT REID** (rreid2@unl.edu) is a professor of special education at the University of Nebraska–Lincoln. His current research interests include strategy instruction and self-regulation for students with learning disabilities and attention-deficit/hyperactivity disorders. **STEVE GRAHAM** (steve.graham@vanderbilt.edu) is the Currey Ingram Professor of Special Education and Literacy at Vanderbilt University. His current research interests include writing instruction, writing development, and self-regulation.

CAROLINE KOH (caroline.koh@nie.edu.sg) is an assistant professor of psychological studies at the National Institute of Education at Nanyang Technological University in Singapore. Her current research interests include motivation, cooperative learning, moral development, values education, and, more recently, simulation-based learning. **C. K. JOHN WANG** (john.wang@nie.edu.sg) is an associate professor of physical education and sports science at the National Institute of Education at Nanyang Technological University in Singapore. His current research interests include sport ability beliefs, achievement goal theory, and self-determination theory. **OON SENG TAN** (oonseng.tan@nie.edu.sg) is the dean of Foundation Programs as well as head and associate professor of psychological studies at the National Institute of Education at Nanyang Technological University in Singapore. His current research interests include educational psychology and problem-based learning. **WOON CHIA LIU** (woonchia.liu@nie.edu.sg) is sub-dean of Foundation Programs as well as assistant professor of psychological studies at the National Institute of Education at Nanyang Technological University in Singapore. Her current research interests include motivation and self-concept as well as innovative teaching strategies, such as project work and problem-based learning. **JESSIE EE** (jessie.ee@nie.edu.sg) is an associate professor of psychological studies at the National Institute of Education at Nanyang Technological University in Singapore. Her current research interests include mathematics, special education, learning difficulties, motivation, strategy-based instruction of teachers, and self-regulation.

MELANIE PICKENS (mpickens@madisoncity.k12.al.us) is chair of the Science Department at Bob Jones High School in Madison, Alabama. Her current research interests involve interactive and hands-on approaches to teaching chemistry as well as teachers' role as primary motivators in their students' performance. **CHARLES J. EICK** (eickcha@auburn.edu) is an associate professor of science education at Auburn University. His current research interests include beginning science teaching and the use of inquiry-based practices.

TOVA MICHALSKY (michalt@mail.biu.ac.il) is a senior lecturer in the Science Education Department at Bar-Ilan University in Israel. Her current research interests concern metacognitive learning and thinking, science problem solving, and science communication in different learning environments (e.g., cooperative learning, advanced technologies). **ZEMIRA R. MEVARECH** (mevarz@mail.biu.ac.il) is head of the School of Education at Bar-Ilan University in Israel. **LIORA HAIBI** (liora_h1@walla.co.il) is a Science Teachers Mentor. Her current research interests involve the reading of science texts.

NOOR AZINA ISMAIL (nazina@um.edu.my) is an associate professor in the Faculty of Economics and Administration at the University of Malaya in Malaysia. Her current research interests include mathematics and science education as well as gender issues regarding achievement and educational economics.

SHU-SHEN SHIH (shusshen@nccu.edu.tw) is a professor at the Institute of Teacher Education at National Chengchi University in Taiwan. Her current research interests involve factors related to Taiwanese adolescent students' achievement motivation from the perspective of self-determination theory.