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Ethnicity and academic achievement by Malaysian eighth grade students

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ETHNICITY AND ACADEMIC ACHIEVEMENT BY MALAYSIAN EIGHTH GRADE STUDENTS

By

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Malaysia's preferential policies have reduced the educational *attainment* gap between ethnic groups. However, we know less about their effects on ethnic differences in academic *achievement*. With this point in mind, the overall goal of this study is to examine inter-ethnic differences in mathematics and science achievement based on the cohort of eighth grade (Form 2) Malaysian students who participated in the Third International Mathematics and Sciences Study Repeat Project (TIMMS-R). It sought to determine the extent to which theoretical propositions of the structural and cultural perspectives developed to explain achievement differences in the United States are applicable in Malaysia. Malaysia is an interesting setting for the purpose of the present study for three reasons. First, the interethnic differences in educational outcomes were historically linked to occupational structure and class-and ethnicity-based residential segregation during the Brisish colonial rule. Second, Malaysia is one of the few countries (i.e. Fiji, Nigeria, Sri Lanka, Uganda, India, and New Zealand) that have strong public policies to rectify the historical ethnic inequalities in access to education. However, the

difference between Malaysia and these countries seems to be in the relative status of the formerly disadvantaged ethnic group in question. Finally, as a new member of the New Industrialized Countries (NICs), Malaysia is in the process of making the transition from an agricultural economy to an indutrialized nation. As such, the importance of mathematics and science education increases along with socioeconomic and technological advance and the discrepancies in mathematics and science achievement can have important implications on socioeconomic disparity among ethnic groups. The primary contribution of this dissertation is that it holistically examines how individual, family and school characteristics affect mathematics and science achievement of the eighth graders in Malaysia. The multilevel modeling analyses showed that Non-Malay students performed significantly better in mathematics achievement than Malay students, even after controlling for family and school characteristics as well as students' perceived importance of mathematics and educational expectations. Overall, the results suggest that the structural and cultural perspectives work differently for Malay and Non-Malay students.

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CHAPTER I

INTRODUCTION

Statement of the Problem

Ethnic differentials in educational attainment and achievement have been characterized as an enduring social issue that has caught many social scientists' research interests (Liew and Post 2005). Based on an extensive review of literature, Pong (1999) noted that ethnicity has been a major area of concern and contention in education policy for as long as there has been public schooling in many countries.

Malaysia is an interesting setting for the purpose of the present study for three reasons. First, the interethnic differences in educational outcomes were historically linked to occupational structure and class-and ethnicity-based residential segregation during the Brisish colonial rule (Hisrchman 1975 and 1979). Second, Malaysia is one of the few countries (others include Fiji, Nigeria, Sri Lanka, Uganda, India, and New Zealand) that have strong public policies to rectify the historical ethnic inequalities in access to education. However, the difference between Malaysia and these other countries is the relative status of the formerly disadvantaged ethnic group in question. Since formerly disadvantaged Malay group is the majority ethnic group that dominates the government, Malaysia should more easily achieve equality in educational attainment (Pong 1999). Finally, as a new member of the New Industrialized Countries (NICs), Malaysia is in the process of making the transition from an agricultural economy to an industrialized nation. As such, the importance of mathematics and science education increases along with socioeconomic and technological advance and the discrepancies in mathematics and science achievement can have important implications on socioeconomic disparity among ethnic groups.

Malaysia's preferential policies have reduced the educational *attainment* gap between ethnic groups. Despite all the evidence that convincingly underscores the increased educational level of the Malays, as a result of the preferential policies, we know little about their effects on ethnic differences in academic *achievement*. Over the past three decades, concerns about ethnic differences in mathematics and science achievement, especially ethnic differences in mathematics learning and achievement, has frequently galvanized public opinion and attracted the attention of Malaysian policy makers. Most studies that employ classroom observations and in depth interviews reveal that Malays still lag behind their Non-Malay counterparts in mathematics achievement at all levels of schooling. Due to the qualitative and exploratory nature of these studies, their findings were far from conclusive, thus limiting the possibility to generalize the findings to the larger Malaysian society. With this in mind, this dissertation attempts to explore reasons for ethnic variations in the eighth graders' mathematics and science achievement using the 1999 Third International Mathematics and Sciences Study (TIMMS-1999).

General Background

Malaysia, a small country with a population of about 21 million, is located in Southeast Asia with a noncontiguous land mass. It consists of Peninsular Malaysia, bordered by Thailand to the north, Singapore to the south, and East Malaysia, on the island of Borneo by the South China Sea. Malaysia is made up of people from different races that use different languages, and practice several different religious beliefs. The three main ethnic groups in Malaysia include the Malay-Muslim majority (60%), the Chinese (27%), and Indian minorities (9%) (Lim 2003). This three ethnic categorization (by no means culturally homogenous within themselves) was created by the British colonial government (Pong 1999). As a result of the British colonial government's policy of unrestricted immigration and the practice of separate educational systems for different ethnic groups, Malaysia became an ethnically stratified society.

Having been a British colony for a few centuries, this colonial legacy had serious implications for ethnic inequality and the development of a national system of education in the post-independence period. Under the colonial system, the differences in educational attainment were historically linked to occupational structure and class- and ethnicity-based residential segregation (Hirschman 1975 and 1979). In Malaysia, the indigenous Malays have traditionally held political power, whereas the Chinese and Indian populations have traditionally controlled most of the wealth in the country. Prior to Malaysia's independence in 1957, Malays were largely disadvantaged in accessibility to education and employment arenas (Hirschman 1975 and 1979). On the other hand, the Chinese and Indian populations, who lived in urban areas, gained a valuable foothold on social mobility because they surpassed Malays in access to schooling (Loh 1975). As a result of British education system's treatment of different ethnic groups, there are persisting socioeconomic gaps between Chinese, who have achieved high levels of earnings and education, and their Malay counterparts, who still lag behind the Chinese in the early years of independence (Hirschman 1975 and 1979).

The economic domination of Chinese intensified Malays' feelings of economic and educational deprivation, which exploded into a bloody ethnic riot in May of 1969 directed mainly against ethnic Chinese. Prompted by that riot, the New Economic Policy (NEP) was implemented in 1971 to achieve greater social equity through educational and other reforms. This preferential policy has been given a constitutional status (Kassim 1997). Article 153 of the Malaysian Constitution authorizes a mechanism "to safeguard the special position of the Malays through a system of quotas" applied to scholarships and to educational training, among other areas (Kassim 1997), which allowed the newly independent Malaysian government to institute radical measures to narrow gaps in education, employment, ownership, and income between the Malay majority and Non-Malays (particularly the economically dominant Chinese). The government expanded opportunities for schooling while adopting a strict policy of affirmative action to tertiary education institutions that discriminated positively in favor of the Malay population and against the Chinese and Indians. The NEP is an example of a policy giving preferential treatment to the majority ethnic group (Pong 1999). Consequently, in the last three decades Malaysia has experienced a dramatic growth of educational attainment with a rapid erosion of ethnic differentials in such attainment.

Based mainly on the Malaysian census data and the first and second waves of the Malaysian Family Life Survey (MFLS-1 and MFLS-2), several studies have analyzed and discussed the effects of the NEP on educational attainment. For instance, using the 1970 Census of Population of Peninsular Malaysia, Hirschman's research revealed a surprisingly prominent and strong role that governmental policies played in reducing the interethnic educational inequalities after independence (Hirschman 1975). However, other studies consistently documented differential effects of the NEP on primary and secondary school attainment for Malays, Chinese, and Indians (De Tray 1984; Pong 1993; Selvaratnam 1988; Tzannatos 1991; Wang 1978). Overall, an array of research findings shows that the NEP remarkably increased the educational level of the Malays, and this effect is most apparent among the younger generations (Hirschman 1979; Pong 1993; Suddha 1997). Indeed, Malays were shown to be more likely than Chinese and Indians to complete primary school and to move on to secondary school (Pong 1993; Sudha 1997). According to Sudha (1997), educational attainment is now highest for Malays, followed by the Chinese and Indians. Researchers have been able to explain a sizable portion of the Malay-Chinese/Indian differentials in primary and secondary attainment by variables such as parents' education and occupation, family income, place of residence (Pong 1993), and family size (Sudha 1997). Pong's (1993) study also showed a clear positive effect of mother's education, particularly at the secondary level. These findings suggest that Malaysia is one of the few countries that have improved educational opportunities for the formerly disadvantaged ethnic group. Even though Malaysia's preferential policies have reversed the educational *attainment* gap between ethnic groups (Hirschman 1975 and 1979; Pong 1993; Suddha 1997), we know less about their effects on ethnic differences in academic *achievement* at the primary and secondary level, largely due to the lack of data. Despite the fact that systematic research on interethnic differences in mathematics achievement is not well documented, disparities in mathematics achievement between Malays and Non-Malays students have concerned educators, researchers, and policymakers at all levels for the past few decades (Mohamad-Ali 1995; Khalid 1997; Lim and Saleh 2002; Mokshein 2002; Lim 2003).

Table 1: Poverty Incidence by Ethnic Groups (%), 1970-1990

	1970	1976	1984	1987	1990
Malay	64.8	56.4	25.8	23.8	20.8
Chinese	26	19.2	7.8	7.1	5.7
Indians	39.2	28.5	10.1	9.7	8
Others	44.8	44.6	22	24.3	18
Average	49.3	35.1	18.4	17.3	15

Source: Yusoff et al. 2000, p. 48

The trends in poverty incidence presented in Table 1 suggest that there is a reduction in poverty incidence in all three ethnic groups from 1970 to 1990. Even though the Malays began at a much higher level of poverty incidence, the reduction in poverty incidence is more rapid among the Malays than among Chinese and Indians. Decline in other ethnic groups follow the same pattern.

Table 2: Ownership of Share Capital of Limited Companies at Par Value

	1970	1990
Malay	2.4	20.3
Chinese	27.2	45.2
Indians	1.1	1
Nominee companies	6	8.5
Foreigners	63.3	25.1

Source: Simpson, 2005, p. 54

Table 2 suggests that there is an increase in ownership of share capital of limited companies among the Malays and Chinese from 1970 to 1990. The ownership of share capital of limited companies among the Indians remains relatively the same from 1970 to 1990. The increase in ownership of shared capital of limited companies is more rapid among the Malays than among the Chinese.

Table 3: Percentage Distribution of Employed Males by Occupational Composition and Ethnic Groups, Peninsular Malaysia, 1957, 1967, and 1999.

	1957			
Industry	**Total**	**Malay**	**Chinese**	**Indian**
Professional and technical workers	2.9%	2.7%	2.8%	2.6%
Administrative, executive, managerial workers	1.5	0.2	2.6	1.3
Clerical workers	3.6	2.2	4.4	5.3
Sales workers	10.3	2.8	19.3	13.4
Service workers	9.1	8.7	5.9	8.9
Craftsmen and production process workers	11.6	4.9	20.2	13.4
Transport and communication workers	4.1	3.7	4.6	4.7
Miners	0.1	0.0	0.2	0.1
Laborers	6.5	4.3	7.3	12.8
Agricultural worker	50.1	69.8	32.3	37.2
Not reported	0.4	0.3	0.4	0.3
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**
	1967			
Industry	**Total**	**Malay**	**Chinese**	**Indian**
Professional and technical workers	5.1%	5.1%	4.6%	5.4%
Administrative, executive, managerial workers	2.2	1.0	4.0	1.6
Clerical workers	4.8	3.2	6.2	6.6
Sales workers	10.5	4.4	19.7	9.3
Service workers	6.1	5.8	5.7	8.0
Craftsmen and production process workers	12.6	6.9	20.3	13.4
Transport and communication workers	5.2	4.7	5.5	6.2
Miners	1.1	0.4	2.0	0.9
Laborers	9.1	8.7	8.5	13.5
Agricultural worker	43.2	59.8	23.5	34.9
Not reported	0.0	0.0	0.0	0.1
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**
	1999			
Industry	**Total**	**Malay**	**Chinese**	**Indian**
Agricultural, forestry, livestock, and fishing	16.2%	15.3%	6.5%	10.6%
Mining and quarrying	0.4	0.4	0.3	0.5
Manufacturing	22.4	24.3	21.7	34.4
Electricity, gas, and water	0.6	0.8	0.3	1.1
Construction	7.6	5.8	11.7	4.2
Wholesale and retail trade, restaurants, and hotels	19.9	16.1	31.3	14.8
Transport, storage, and communication	5.2	5.4	4.4	8.1
Finance, insurance, real estate, and business services	5.8	4.9	8.2	6.9
Community, social, and personal services	22.0	27.0	15.7	19.3
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Source: Hirschman 1975 and Malaysian Labour Force Survey 1999

Even though it is difficult to make true comparisons because the data come from different sources, Tables 3 suggests that ethnic differentials in occupational composition narrowed between 1957 and 1967 (Hirschman 1975), and then rapidly narrowed again in 1990. This suggests a trend towards ethnic equality in occupational composition over the last few decades. There seem to have a general upgrading of the occupational structure in all three ethnic communities with reductions in agricultural employment and increases in white-collar and occupations. Between 1957 and 1967, the movement out of agricultural employment and the increase in white-collar occupations is more rapid among the Chinese and Indians than among Malays (Hirschman 1975). The movement out of agricultural occupations during this period can be attributable to rural over-crowding (too many people to inherit too little land), higher wages in urban areas, increasing education of rural youth, and decreasing prices for agricultural products (Hirschman 1975). The increase in white-collar occupations can be attributable to the growth of public sector and large-scale commercial enterprises (Hirschman 1975). After 1990, the rapid reduction in agricultural employment in all three ethnic communities is attributable to the transition of Malaysia from an agricultural economy to an industrialized nation in this period.

Significance of the Study

In many developing countries like Malaysia, secondary school curricula show both the impact of Westernization, and in many cases, a special interest in science and mathematics, which are thought to contribute to rapid industrialization (Brint 1998, p. 118). In developed and developing countries alike, math and science curricula are associated with economic progress (Brint 1998, p. 119). As the importance of mathematics and science education increases along with socioeconomic and technological advance, it seems quite likely that individuals who lack aptitude in these areas will be increasingly disadvantaged in terms of occupational and social mobility. Since education is an instrument for national development, national unity and personal development, the discrepancies in mathematics and science achievement may contribute to socioeconomic disparity among ethnic groups.

Even though Malaysia's preferential policies have successfully ensured a higher rate of increase in Malays' entry into primary, secondary and post-secondary education (Hirschman 1975 and 1979; Pong 1993; Suddha 1997), qualitative research revealed that Malays students still lag behind their Non-Malays counterparts in mathematics achievement at the primary and secondary school levels (Lim and Saleh 2002; Mokshein 2002; Lim 2003). These discrepancies in mathematics achievement have concerned educators, researchers, and policymakers for the past few decades (Mohamad-Ali 1995; Khalid 1997; Lim and Saleh 2002; Mokshein 2002; Lim 2003). Since the discrepancies in mathematics and science achievement can become an important indicator for ethnic stratification in a multiethnic society like Malaysia, a comparative study of the inter-ethnic differences in mathematics and science achievement is more essential than ever as this unique understanding would assist Malaysian policy makers toward a more rational choice in implementing educational policies.

This study chooses to focus on 8th grade students because at the end of 9th grade, students are required to take a compulsory national examination and the results of this examination will determine their choices of academic streams (i.e., Arts or Science) for the next two years in upper secondary school (equivalent to 10th and 11th grade in the

U.S.) are strongly dependent on their scores in this examination. As such, it is reasonable to suppose that 8th graders in Malaysia should have a sensible idea of their educational expectations and career goals at this level. Hopefully, the results of this study will help the Ministry of Education (MOE), schools, teachers, and parents to identify ways to improve student's achievement in mathematics and science and in formulating policies pertaining to resource allocation in the improvement efforts in mathematics and science education.

Research Questions

The main objective of this study is to examine whether there are any ethnic differences (i.e., Malay and Non-Malay) in mathematics and science achievement among eighth graders in Malaysia. Specifically, this proposed study is aimed at answering the following questions:

1. Are there any differences in mathematics and science achievement between Malay and Non-Malay students? If so, do they persist after controlling for family characteristics (e.g., family living arrangement, family size, parent's education, and the number of books and educational objects at home), student's perceived importance of the subject, shadow education and school characteristics?
2. Do the effects of family characteristics (i.e. family living arrangement, family size, parent's education, and the number of books and educational objects at home), student's perceived importance of the subject, and shadow education (the number of hours the student reported spending on extra classes in

mathematics and sciences before or after school in a week) vary across Malay and Non-Malay students? Put differently, do the effects of the above-mentioned variables differ across ethnic groups?

Organization of Chapters

The overall goal of this dissertation is to examine inter-ethnic differences in mathematics and science achievement of grade eight (Form 2) Malaysian students. It seeks to determine the extent to which theoretical propositions of the structural and cultural perspectives developed to explain achievement differences in the United States are applicable in Malaysia as the importance of mathematics and science education increases along with the country's socioeconomic and technological development.

The remaining part of this dissertation is organized into five major chapters. The second chapter is a review of literature on factors related to students' achievement in school. The third chapter details the methodology employed in the study. The fourth chapter reports the results of the study, and the fifth chapter first summarizes the findings, then presents conclusions and discussions, which will be followed by policy implications and recommendations.

CHAPTER II

REVIEW OF THE LITERATURE

This chapter outlines an overview of the Malaysian education system and a review of relevant literature on family background factors, student personal characteristics, shadow education, student attitudes toward school and careers, educational expectations, and school characteristics that may influence mathematics and science achievement of Malaysian eighth grade students. The purpose of the review is to look at what others have found in this area of study as well as indicate worthwhile topics that have received limited attention in research.

The Malaysian Educational System

The Malaysian education system is based on the British model due to its past ties to the colonial master. There are three types of primary schools: Malay medium national schools (SK), Chinese medium national schools (SRJKC), and Tamil medium national schools (SRJKT). In Malaysia, all national schools follow a common mathematics and sciences curriculum even though the medium of instruction is different (Lim and Saleh 2002). Being a multiethnic and multicultural country, Malaysia has unique characteristics that may make its determinants of mathematics and science achievement distinct from those of its neighbors in the region.

Malaysia’s ethnic stratification originated from the British colonial government’s policy of unrestricted immigration and its practice of maintaining separate educational systems for different ethnic groups. This colonial legacy of ethnic inequality affected the development of Malaysia’s national system of education in the post-independence period. Under the colonial system, differences in educational attainment were historically linked to occupational structure and class- and ethnicity-based residential segregation (Hirschman 1975 and 1979). In Malaysia, indigenous Malays control the political system, while the Chinese has been the driving economic force in the country (Agadjanian and Liew 2005). Prior to Malaysia’s independence in 1957, Malays were disarticulated from the social mobility processes because the British relegated them to rice production to provide for the growing Chinese and Indian labor force (Loh 1975). On the other hand, the Chinese and Indian populations, who lived in urban areas, gained a valuable foothold in social mobility and surpassed Malays in access to schooling because of their early involvement in trade and business (Loh 1975). Partly as a result of the British education system's differential treatment of Malaysia’s ethnic groups, socioeconomic gaps emerged between Non-Malays, who obtained high levels of earnings and education, and their Malay counterparts, who lagged behind Non-Malays during the colonial period (Hirschman 1975 and 1979).

Malaysia’s independence marked a political victory for Malays, who are Muslim and speak a different language than Non-Malays. Malaysia obtained its independence from the British in 1957. In 1961, the Education Act and the National Education Policy were introduced in order to establish a national system of education. The newly independent Malaysian government also made the Malay language the sole official language of the country, as well as the medium of instruction in all government schools, colleges, and universities. As a result of the Education Act and the National Education Policy in 1961 and the National Economic Policy in 1971, Malaysia has experienced a dramatic growth of educational attainment with a rapid erosion of ethnic differentials in such attainment.

Formal schooling in Malaysia begins at age seven, and education is compulsory and free through the secondary level. There are six years of official primary schooling, known as Standard 1-6. Most children will opt to enter government-funded primary schools. This kind of education is provided in Bahasa Malaysia, Chinese, and Tamil languages, depending upon the student's own language. Private primary schools are also an option even though they are only popular among the social elite. Secondary education is the continuation of primary education, consisting of lower secondary and upper secondary levels. The period of study for the lower secondary level covers three years (Form One through Form Three). At the end of this period, students are required to take a compulsory national examination; passing this examination is required if one wishes to continue into upper secondary education. Students' performances on that test determine their academic streaming to the upper secondary level (i.e. whether they will be in sciences, arts, technical, or vocational streams). The period of study for upper secondary education covers two years (Form Four to Form Five). At the end of this period, students are assessed by another compulsory national examination. Students must pass this compulsory national examination in order to gain admission to almost any post-secondary educational program. Post-secondary education in Malaysia is generally classified into two groups: (1) the government-funded (Lower Form 6 and Upper Form 6) and (2) the private post-secondary educational programs (certificate, diploma, and other university degree programs). Only the best students typically enter Lower Form 6 and Upper Form 6. The final examination taken at the end of Form 6 is extremely difficult. Good results in this examination are a requirement for entry into most local universities. In this study, I focus on inter-ethnic differences in mathematics and science achievement of eighth grade (Form 2) Malaysian students.

Theoretical Perspectives

Ethnic differentials in educational attainment and achievement have been characterized as an enduring social issue, catching the interest of many social scientists. Pong (1999) noted that ethnicity has been a major area of concern and contention in education policy since the existence of public schooling in many countries. Two sociological approaches have been found useful in explaining the Malays-NonMalay disparities in educational attainment: the structural perspective and the cultural perspective (Fejgin 1995).

The structural perspective has its roots in the earlier works of the status attainment tradition that established the importance of educational expectations on educational achievement and other school outcomes, both within and across ethnic groups (Blau and Duncan 1967; Duncan and Duncan 1968; Sewell and Shah 1968; Sewell and Hauser 1975; Hauser, Tsai and Sewell 1983). The structural perspective suggests that ethnic differences in educational attainment can be mostly explained by the traditional socioeconomic characteristics (e.g. parent's education, parent's occupation, and family income / wealth). According to Hirschman and Falcon (1985), this perspective attributes variation between ethnic groups in educational attainment to compositional and structural factors (e.g. SES, school socioeconomic characteristics, school geographical location, and family generational composition) rather than cultural factors. Thus, it seems that the financial capital (wealth and family income) and human capital (educational attainment) of parents may facilitate their children's access to education (Coleman 1988). Parents of higher SES are more able to afford moving to locations with desirable schools and can better afford tutoring or private education after school (Pong 1999). They are also more adept in developing social networks or social capital that can be used as a means to support their children's education (Coleman 1988). In other words, parents will attempt to convert their financial and human capital into actions that may help their children develop their own human capital. According to this perspective, "most of the education differences across ethnic groups result from variations in socioeconomic backgrounds, with the more educationally advantaged groups having higher socioeconomic status" (Pong 1999). The structural perspective posits that the relationship between ethnic groups will be reduced or eliminated when parental SES is controlled (Hirschman and Falcon 1985). The structural perspective also emphasizes social structures and situational constraints that individuals may encounter and be affected by throughout life (Hirschman and Falcon 1985).

The cultural perspective provides an alternative way of explaining ethnic differences in educational achievement in Malaysia. According to this perspective, it is not parents' SES, but their cultural traditions, ethnic traits, and cultural values contribute to the possibility of educational success (Pong 1999). This perspective also suggests that "some ethnic groups are able to achieve, in spite of discrimination, because their culture places a premium on ambition, persistence, deferred gratification, and social mobility" (Hirschman and Falcon 1985, p. 84). "Ethnicity" is often used interchangeably with "race" in Malaysia's political discourse (Pong 1999). Even though Malaysia's three major ethnic groups (Malays, Chinese, and Indians) have very different cultural characteristics, particularly their language and religion, their differences in visible physical attributes among them are relatively small (Pong 1999).

Malaysian Chinese are descendents of early 19th century immigrants from China (Pong 1993). Embedded in the Confucian tradition, the Chinese culture is heavily focused on learning (Sun 1998). Traditional Chinese culture has, in many ways, reinforced the values of education and academic success and continued respect for authority (Sun 1998). Chinese immigrants bring these ethnic traits to Malaysia and transmit them to succeeding generations (Pong 1993). In addition, for centuries, the Chinese have been exposed to adverse conditions such as war, economic deprivation, and ethnic animosity (Pong 1993 and 1999). Therefore, they have learned to adapt to changing environments to survive and prosper (Pong 1993). Despite their initial low social status, the cumulative and enduring influence of Chinese culture has motivated many Chinese to attempt to climb the socioeconomic ladder throughout Southeast Asia, including Malaysia (Agadjanian and Liew 2005). As a result, the wealth of the Chinese made them the primary target for the political upheavals centered on the issue of ethnicity and socioeconomic inequality in Malaysia's riot of 1969 (Agadjanian and Liew 2005).

Like the Chinese, Malaysia's Indians are part of a diaspora that has taken Indians all over the world. The Indian population in Malaysia is primarily composed of Tamils, who were first brought to Malaysia from South India to work on large rubber and oil palm plantations (Agadjanian and Liew 2005). Like the Chinese, some Indians managed to climb up the socioeconomic ladder, especially the so-called *chettis* (money lenders). Indians were also targeted in the ethnic confrontations of 1969 (Agadjanian and Liew 2005). However, compared to the Chinese, the general SES of the Malaysia's Indian population has remained lower, due to the lack of educational and employment opportunities (Agadjanian and Liew 2005).

Malays, who constitute approximately 60 percent of Malaysia's population, come from a predominantly agrarian background. The traditional Malay culture does not emphasize social mobility, economic success, or educational attainment as much as the Chinese and Indian culture (Pong 1993; Agadjanian and Liew 2005). The situation of Malays during the British colonial rule resembles that of the Italians who first came to America. Early Italian immigrants were mainly from southern Italy and were exclusively peasant farmers (Covello 1967). Because school represented the subculture of northern Italy, these Italians were distrustful of schools because little of what was taught in school was of much importance to their lives as farmers (Covello 1967). Covello (1967) concluded that these cultural values acted as obstacles to the educational and occupational progress of early Italian immigrants. Malays also differ from the Chinese and Indians in that most are Muslim (Agadjanian and Liew 2005). Therefore, the cultural and religious differences among Malays, Chinese, and Indians might serve as a basis for explaining their differences in educational and occupational achievement until the 1970s (Agadjanian and Liew 2005). From this perspective, one would argue that even with equivalent socioeconomic backgrounds (same origin and education), Malays would be less likely to achieve because they are less motivated (Hirschman 1975).

Indeed, Pong's (1993) research suggests that SES alone does not account for the existence of ethnic differences, much less for the fact that Malays attained more years of schooling than the Non-Malays after the policy. She considers strong state policy that alters the structure of economic and educational policies for each ethnic group, followed by cultural change among the Malays in response to the economic environment, as a driving force for such educational reversal (Pong 1999). Even though cultural beliefs and values are learned early in the family, the preferential policy has remarkably changed Malays' self-images, self-confidence, and attitudes towards schooling, and these changes are key elements for school success (Pong 1999).

Research in the United States has found support for both the structural and cultural perspectives. The support for structural perspective is found in studies by Hirschman and Falcon (1985) and Gans (1992). Using the 1977-83 General Social Surveys, Hirschman and Falcon (1985) attempted to study the educational attainment of 25 religio-ethnic groups in the United States. They found that neither generation nor length of U.S. residence significantly affects educational outcomes. Specifically, children of highly educated immigrant groups consistently fared much better in school than fourth-or-fifth generation descendants of poorly educated ancestors, regardless of religio-ethnic backgrounds (Hirschman and Falcon 1985). They concluded that parental schooling is the most important factor explaining educational differences across religio-ethnic groups (Hirschman and Falcon 1985). Unlike Hirschman and Falcon, who only looked at one dimension of SES (i.e. parents' education), Gans (1992) took parent's income, job security, and work conditions into account in his attempt to explain the differences in occupational achievements among different ethnic groups in United States.

He found that it is more difficult for immigrant children from less fortunate socioeconomic backgrounds (working class, poorly educated parents) to succeed in school than it is for middle class children. He then painted a bleak economic scenario for the future of Black and Hispanic immigrant children.

The cultural perspective is supported by Perlmann's (1988) study of Irish, Italian, Jewish, and African Americans in Providence, Rhode Island, which suggests that even with family background factors held constant, ethnic differences in levels of schooling persisted in second and later generations. Even though Perlmann provided a detailed examination of educational attainment patterns and the importance of schooling for occupational and economic success in Providence, his research only focused on Rhode Island, and this dictates caution in generalizing these findings to the larger American society.

In another related study by Annette Lareau, she found that parents' different social classes are associated with different value orientation and cultural logic of childrearing. Parenting styles differ among middle-class and working-class parents because they define their own roles in their children's lives and perceive the nature of childhood differently (Lareau 1987 and 1992). Both Black and White middle-class parents tend to conform to a "cultivation" approach in childrearing (Lareau 1987 and 1992). Middle-class parents view the participation of age-specific organized activities as transmitting important life skills to children (Lareau 1992). On the contrary, both Black and White working-class parents tend to conform to an "accomplishment of natural growth" approach in childrearing (Lareau 1987 and 1992). In these parents' view, as long as they provide love, food, and safety, their children will grow and thrive (Lareau 1987 and 1992). They do not emphasize developing their children's talents in organized activities (Lareau 1992). Thus, middle-and working-class children have different resources to draw on in their interactions with professionals and other adults outside the home (Lareau 1992).

Quantitative research in Malaysia found support for the structural perspective. Pong's analysis of the 1988 Malaysian Family Life Survey showed a clear positive effect of mother's education on student's secondary school attainment. Qualitative research in Malaysia also found support for the cultural perspective. The general cultural effects on mathematics teaching and learning have also been clearly established in studies by Lim and Saleh (2002) and Lim (2003). Using classroom observations and in-depth interviews, these researchers found that even though mathematics is taught in every Malaysian school, with the same national curriculum, the culture of teaching and learning mathematics differs between schools. According to these researchers, two components of socioeconomic status, parental income and education, are necessary but not sufficient in explaining Chinese student success in mathematics achievement. Lim's (2003) study also indicates that Chinese student success in mathematics achievement is assumed to be directly related to the unique traditional Chinese culture of education. Specifically, the dominant culture of drill and practice contributes to the better mathematics achievement of Chinese primary schools (Lim 2003). A related finding by Lim's (2003) study is that Chinese students' mastery of mathematics can be strengthened by the Chinese numbering system, which is easier and more systematic than other forms of numbering systems.

Other empirical research in both developed and developing countries (e.g. Hauser and Featherman 1977; Featherman and Hauser 1978; Jones 1987; Steelman and Powell

1991; Hout et al. 1993; Pong 1993; Kao and Tienda 1995; Kennedy and Park 1994; Portes and MacLeod 1996; Warren 1996; Bianchi and Robinson 1997; Hofferth, Boisjoly and Duncan 1998; Keister 2000; Conley 2001; Lucas 2001; Treiman 2001) have controlled for socioeconomic characteristics in their attempts to explain differences in educational achievement among ethnic groups discussed, but these researchers have yet to fully test the structural perspective as a major explanatory concept. Thus, this proposed study will use TIMSS 1999 to examine whether Malay-Non-Malay differentials in mathematics and science achievements reflect the structural or cultural hypotheses. A second goal of this study is to address whether the effects of family and school socioeconomic characteristics and family generational composition vary across Malay and Non-Malay students.

Student Characteristics and School Outcomes

Gender and School Outcomes

Researchers from the United States, Canada, and Malaysia have examined the gender dimension of mathematics and science achievement, focusing on girls' educational opportunities and achievement. According to these researchers, the fact that boys generally do better in mathematics and science than girls has been widely recognized, and a number of different explanations has been posited for the observed differences (Parsons, Adler and Kaczala 1982; Parsons, Kaczala and Meece 1982; Catsambis 1994; Muller 1998; Zhang 1999; Mokshein 2002; Sandefur and Campbell 2002).

Gender is not just an attribute that describes an individual. It can also be regarded as a structural feature of inequality in organizations, social relations, and legislative systems. Terms like gender identity can be used to conceptualize personal attributes that are related to gender as it is defined in the social structure. Gender as a structural feature has been considered by studies in the United States. (i.e. Muller 1998; Parsons, Adler and Kaczala 1982; Parsons, Kaczala and Meece 1982). Evidence from these studies suggests that gender differences appear primarily in differential treatment of boys and girls in classrooms, different advice given to boys and girls by high school teachers and counselors, and limited opportunity for girls in mathematics and science.

In addition to being an attribute of an individual or a structural system, gender is also a cultural construct. Gender as a cultural construct has also been considered by studies in the United States. (i.e. Catsambis 1994; Muller 1998; Parsons, Adler and Kaczala 1982; Parsons, Kaczala and Meece 1982; Zhang 1999). Evidence from these studies suggests that gender differences appear primarily in attitudes toward the subject and differential expectations of parents and teachers. Gender identities are critical aspects of culture because they not only influence life in the family, but also life in workplace and the larger society. Because the gender division of labor reasserts old and generally understood cultural meanings of gender, women are still underrepresented in scientific and technical careers despite the increase in female labor force participation. There are clear patterns of “women’s work” and “men’s work” in most societies because of different cultural meanings given to being male or female. Evidence in the United States suggests that many female students tend to lose interest in mathematics and science in middle school because of lack of self-confidence, gender stereotyping, and lack of parental support (i.e. Catsambis 1994; Muller 1998; Parsons, Adler and Kaczala 1982; Parsons, Kaczala and Meece 1982; Zhang 1999). Therefore, it is logical to assume that gender divisions of labor in most societies have different implications on male and female student attitudes, self-expectations, and performance in mathematics and science.

Evidence in Taiwan and Malaysia suggests that educational expansion over the past few decades tends to equalize educational opportunities for men and women. In both Taiwan and Malaysia, girls and boys of later cohorts received a more equal education compared to their counterparts in earlier cohorts (Tsai, Gates, and Chiu 1994; Agadjanian and Liew 2005). Evidence in Taiwan also suggests that the class and ethnic group of more educated children differed markedly from those of less educated children (Tsai, Gates, and Chiu 1994). In Malaysia, Chinese and Indian cultural customs transmit family name, land, houses, and businesses through paternal lines. On the other hand, Malays cultural customs transmit family name, land, houses, and businesses through maternal lines. This study is extremely useful because the Taiwanese educational system, as well as its experiences in terms of educational expansion and equalization, share similarities with that of Malaysia's. To the best of my knowledge, no studies in Malaysia have attempted to examine whether the effects of gender on academic achievement vary across ethnic groups. With this in mind, this proposed study will explore whether the possible influences of gender on eighth grade mathematics and science achievement differ between Malay and Non-Malay students using the Third International Mathematics and Sciences Study Repeat Project (TIMMS-R).

The Impact of Students' Attitudes towards School, Career, and Educational Expectations on School Outcomes

In Malaysia, considerations of the predictors of mathematics and science achievements have increasingly emphasized the significance of student perceptions about the usefulness of mathematics and student enjoyment of it as a school subject. Due mainly to lack of data, most studies that have investigated the issue are primarily based on ethnographic studies and in-depth interviews.

In an attempt to identify the relationship between attitudes toward mathematics achievement among Malaysian school children, Mohamad-Ali (1995) found significant differences in mathematics achievement among 16-year-old students based on their home environment and SES. His research suggests that students' attitudes and educational expectations are the factors that mediate family SES. However, his data were collected from only one east-coast state in Malaysia. Since east coast states are quite different from west coast states in terms of economic development and population, the subjects he described in his study might be different from many (perhaps most) other parts of Malaysia (especially west coast states). Therefore, one should be aware of the limitations in generalizing these findings to all Malaysian students.

In 2000, a group of researchers led by Chap-Sam Lim in Malaysia began a project to explore and identify possible factors that are responsible for the differences in mathematics learning in Malaysian primary schools. In this project, Lim and his colleagues conducted their study on a Chinese elementary school and a Malay elementary school that differed from each other in terms of locality, student family SES, student ethnic composition, and institutional religious affiliation. The group's preliminary reports (Lim and Saleh 2002; Lim 2003) show that student's family SES and home environment affect their views about the utility of mathematics and their enjoyment of it as a school subject. However, because this is a qualitative study, employing mostly classroom observations and in-depth interviews, the findings were far from conclusive, and this dictates caution in generalizing these findings to the larger Malaysian society.

Family Characteristics and School Outcomes

The Impact of Family SES on School Outcomes

The importance of education for occupation, and of family SES for education, led to stratification researchers' curiosity about how differential family SES is translated into children's educational outcomes. These researchers have demonstrated the importance of parental investment in educational, financial, and cultural capital necessary for educational success (Blau and Duncan 1967; Hauser and Featherman 1977; Featherman and Hauser 1978; Steelman and Powell 1991; Bianchi and Robinson 1997; Keister 2000; Conley 2001; Treiman 2001). In fact, it has become clear that family income and parent's education are primary factors that contribute to differences in educational attainment and achievement (Blau and Duncan 1967; Featherman and Hauser 1978). A distinguished legacy of research has demonstrated that students from low-income families tend to perform lower in school compared to their counterparts from middle-and upper-income families (Blau and Duncan 1967; Lareau 1987). Home educational resources, in terms of the extent to which families facilitate student learning by providing desks, computers, calculators, and other educational objects had a small positive effect on achievement in almost all OECD countries (OECD 2001).

Stratification researchers all over the world have also been exploring racial inequality in educational attainment and achievement for decades. The vast majority of these studies have found that family SES is a primary factor contributing to interethnic differences in educational achievement (Jones 1987; Hout et al. 1993; Kao and Tienda 1995; Kennedy and Park 1994; Portes and MacLeod 1996; Warren 1996; Hofferth, Boisjoly and Duncan 1998; Keister 2000; Lucas 2001). Widespread socioeconomic gaps in educational achievement exist not only in industrial countries but also in developing countries (Ishida, Muller and Ridge 1995). Blau (1990) proposed that SES and ethnicity can constrain many individuals from realizing their educational and occupational choices while expanding opportunities for others. These results stress the continuing significance of ethnicity as a fundamental factor that conditions status attainment opportunities and affects the socio-economic prospects of children and future generations.

However, findings pertaining to effects of family SES on educational achievement are mixed. On one hand, Ma (2001), citing Schultz (1993), has shown that socioeconomic gaps often remain strong even after controlling for student and family characteristics such as gender, age, and family size. On the other hand, while many studies (Duncan and Duncan 1968; Bean and Tienda 1987; Jones 1987; Kennedy and Park 1994; Warren 1996; Lucas 2001) report differences in educational achievement among different ethnic groups in a country, the effects of ethnicity weakened or disappeared after controlling for family SES (e.g. parent's education, occupation, income and other family background characteristics).

In Malaysia, Pong (1999) speculated that Malay and Non-Malay families may respond to the preferential policy in very different ways and may adopt different strategies to cope with the policy. Therefore, it is reasonable to suppose that the government's preferential policies, which give favorable treatment to Malays, might alter the family SES effect among Malay and Non-Malay populations. Preferential education policies might have increased the direct costs of being in school for Non-Malays, thereby increasing the family SES effect on children's educational attainment and achievement among Non-Malay populations. Nevertheless, the literature has paid less attention to whether the effects of family SES on academic achievement vary across ethnic groups. With this in mind, this proposed study will explore whether the possible influences of parental ability to use resources (e.g., financial and human capital) to improve children's mathematics and science achievement differ between Malay and Non-Malay students using the Third International Mathematics and Sciences Study Repeat Project (TIMMS-R).

The Impact of the Type of Family Living Arrangement on School Outcomes

There is a major body of literature concerning the association between type of family living arrangement and educational success. Earlier research on type of living arrangement often used limited measures of whether the child was living with both parents, and this measurement strategy did not adequately reveal all alternative childhood living arrangements because it constrained their links with child outcomes to be equal (Teachman 2008). More recent research on type of living arrangement has extended the definition of childhood living arrangement to distinguish among single parents, stepparents and biological parents (Teachman 2008).

Due mainly to increases in divorce rates as well as decreases in marriage or remarriage rates, the living arrangements of children have undergone a massive transformation over the past three decades (Teachman 2008). Several studies from the United States (McLanahan and Sandefur 1994; Pong 1997; Teachman 2008), Europe (McNab and Murray 1985; Murray and Sandqvist 1990; Jonsson and Gahler 1997) and Malaysia (Pong 1996) found that children who grew up in single-parent families experienced lower educational achievement and attainment. Therefore, it is reasonable to suppose that children reared in two-parent families will, on average, receive more socioeconomic, psychological, and social support or more cultural and economic resources than children reared in single-parent families. More widely cited are two explanations: one that emphasizes the lower economic resources of single parents, while the other underscores the fact that single parents are less able to get involved in their children's schooling (Downey 1994; Entwisle and Alexander 1995; McLanahan 1985; McLanahan and Sandefur 1994; Sandefur, McLanahan and Wojtkiewicz 1992; Pong and Ju 2000). According to McLanahan and Sandefur (1994), the educational disadvantage faced by children in single-parent families is not a family effect but simply an economic effect (e.g., poverty).

However, findings on the effects of stepparent families on educational achievement are mixed. Some studies have shown that children in stepfamilies perform below those in intact families (Amato and Keith 1991; Wojtkiewicz 1993; Boggess 1998; Bilbarz and Raftery 1999; Painter and Levine 2000; Ginther and Pollak 2004; Teachman

2008). On the other hand, McLanahan and Sandefur (1994) found that the educational outcomes for stepchildren are essentially the same as outcomes for children in single-parent families.

In Malaysia, the form and functioning of families differ among ethnic groups. Chinese and Indian families rest on cultural assumptions about the permanence of marriage and the household as an ongoing, corporate group whose members are bound by duty, obligation, subordination, and shared income (Kling 1995). In traditional Chinese culture, there are numerous negative stereotypes and metaphors of stepfamilies (Jones 1997). In Chinese families, blood ties are highly valued and affect step-parenting practices. The divorced status of a stepmother carries a social stigma, and her children are looked down upon (Jones 1997). In addition, the continued efforts of Indian parents to arrange marriages or at least influence marital choices of their offspring and the Tamil obligation to provide daughters with large dowries reflects such cultural definitions of family and household (Kling 1995).

Malay families, on the other hand, give priority to the individual and to individual interests (Jones 1981 and 1997; Kling 1995). Malays do not define the household as a continuing body but instead see it as a possibly short-lived coalition of autonomous individuals linked by sentiments of mutual concern and affection (Jones 1981 and 1997; Kling 1995). Malays have traditionally had much higher rates of divorce and adoption than other ethnic groups, and this distinction continued in the 1980s although the divorce rate was lower than it was in the l940s or l960s (Jones 1981 and 1997). More importantly, Malays regard divorce as a realistic and normal, although unfortunate, possibility in all marriages (Jones 1981 and 1997). In Malay families, husbands, wives, and children with jobs hold separate purses and sometimes separate savings accounts and relations between siblings are tenuous (Jones 1981 and 1997; Kling 1995). As such, they do not make long-range strategic plans to maximize family income and success (Kling 1995).

In the case of Malaysia, Pong (1996) found that children of single mothers, as a result of divorce and separation, are at greater risk of leaving school, while children of widowed mothers have similar school participation rates to those of children from two-parent families. Even though evidence from Malaysia suggests that adolescents from single parent families are more likely to leave school, the literature has paid less attention to the effects of type of family living arrangement on academic achievement. In addition, the literature has paid less attention to whether the effects of family size on academic achievement vary across ethnic groups. With this in mind, this proposed study will explore the possible influences of type of family living arrangement on eighth grade mathematics and science achievement and whether such influences differ between Malay and Non-Malay students using the Third International Mathematics and Sciences Study Repeat Project (TIMMS-R).

The Impact of Family Size on School Outcomes

There is a major body of literature concerning the association between family size and educational success. The size of the family affects educational attainment, even among families with similar socioeconomic characteristics (Mare 2001). Two theoretical explanations have been posited to explain the relationship between family size and educational outcomes: the resource dilution hypothesis and the specialization framework.

The resource dilution hypothesis developed by Blake (1985) offers insight into how children's educational attainment and achievement relate to family size. Simply put, as the number of siblings increases, fewer resources (e.g., parental love and attention, finances) are available to facilitate the development of each child, including educational attainment (Blau and Duncan 1967; Steelman and Mercy 1980; Blake 1981 and 1985). Empirical studies from the United States (Blau and Duncan 1967; Blake 1981; Downey 1995), Taiwan (Parish and Willis 1993), Thailand (Knodel and Wongwith 1991), and Vietnam (Anh, Knodel, Lam and Friedman 1998) have confirmed the resource dilution hypothesis. Quite consistently, this body of research has led to the conclusion that children from larger families experience educational disadvantages compared to their counterparts from smaller families and the negative effect persists even after controlling for family socioeconomic status (Knodel and Wongwith 1991; Shavit and Pierce 1991; Parish and Willis 1993; Anh, Knodel, Lam and Friedman 1998).

According to the specialization framework, older siblings may improve the educational outcomes of younger siblings by providing interpersonal and direct financial resources because older children may work outside the home, freeing younger children for school (Parish and Willis 1993). It is not surprising then that the negative effects of larger family size on educational outcomes may be offset or even reversed by the support given to younger children by older siblings. Evidence from Kenya (Gomes 1984) and Botswana (Chernichovsky 1985) seems to provide support for the specialization framework. The findings reveal a positive relationship between family size and educational attainment (Gomes 1984; Chernichovsky 1985). This positive association can be attributed to the specialization of roles in the family in most developing countries (Parish and Willis 1993).

There is an important study by Guo and VanWey in 1999. Using change models, Guo and VanWey (1999) questioned whether there is a causal, negative relationship between sibship size and children's educational outcomes. They used fixed effects regression models to control for the unobserved heterogeneity that confounds cross-sectional designs. By using one sibling virtually as a control for another one, they found that once sources of time-constant unobserved heterogeneity are controlled for, there is no statistically significant effect of family size on educational outcomes for Whites, Blacks, and Hispanics racial groups. In fact, the direction of the association is positive. Therefore, this study provided support to the contention that the identified relationships between family size and achievement may be at least partially spurious, due to unobserved heterogeneity on the family level.

Evidence (e.g. Hirshman 1986, Jones 1990, and Suddha 1997) suggests that Malaysia's preferential policies have led to a rapid decline in fertility among the Chinese and Indians relative to Malays in the 1970s. Pong's (1999) review of empirical evidence suggests that from 1965 to 1986, Chinese and Indian total fertility rates declined from 5.6 and 6.7 to 2.4 and 3.0, respectively, while the Malay fertility declined only from 5.5 to 4.7. Pong (1999) also speculated that the government's preferential policies, which give favorable treatment to Malays, might alter the family size effect among Malay and Non-Malay populations. The preferential education policies reduce the direct costs of being in school and thereby constitute a type of external educational support for Malay children (Pong 1999). The educational support to Malay families may weaken the family size effect on children's educational attainment (Pong 1999). Under such conditions, the preferential education policies may have reduced the intra-familial competition for educational resources among Malays siblings. Even though evidence suggests that Malaysia's preferential policies have led to a rapid decline in fertility among Non-Malays, the literature has paid less attention to whether the effects of family size on academic achievement vary across ethnic groups. With this in mind, this proposed study will explore whether the possible influences of family size on eighth grade mathematics and science achievement differ between Malay and Non-Malay students using the Third International Mathematics and Sciences Study Repeat Project (TIMMS-R).

Shadow Schooling and School Outcomes

There is a small international literature on "shadow education" (Stevenson and Baker 1992; Stevenson, Schiller and Schneider 1994; Baker et al. 2001). Evidence suggests that shadow education closely follows the curricula of the main public school system, engages in homework support, test preparation, and cramming schools, and is usually offered by individual tutors (Stevenson and Baker 1992; Baker et al. 2001). Researchers typically trace demand for tutoring to whether countries have post-secondary entrance exams, major status differences among their post-secondary institutions, and direct occupational rewards for entry into those institutions (Stevenson and Baker 1992; Baker et al. 2001). In their attempt to compare mathematics learning among different ethnic groups in Malaysia, Lim and Saleh (2002) and Lim (2003) concluded that most Chinese medium schools favor more drill and practice, as well as more homework and tutoring. Consequently, it is not surprising that Chinese students tend to perform better in mathematics than their Malay counterparts (Lim and Saleh 2002; Lim 2003). Even though evidence suggests that Chinese parents are more likely than Malay parents to send their children to extra classes in mathematics, it is based entirely on classroom observations and in-depth interviews. With this in mind, this proposed study will explore whether the possible influences of shadow education on eighth grade mathematics and science achievement differ between Malay and Non-Malay students using the Third International Mathematics and Sciences Study Repeat Project (TIMMS-R).

School Characteristics and School Outcomes

Research on effects of school characteristics on academic achievement began with IEA's effort to collect international achievement data in the late 1960s. Since then research has been undertaken in the United States (Caldas 1993; Luyten 1994; Lamdin 1995; Ramiez 1990), Australia (Howley 1994; Fetler 1989; McKenzie 1995), Canada (Zhang 1999), Norway (Bonesronning 1996), the Netherlands, Sweden (Luyten 1994), and Malaysia (Khalid 1997; Mokshein 2002) on the relationship between school characteristics and academic achievement at the secondary level. Since then, numerous studies from the United States, Europe, and Mexico have found significant effects of school human, financial, and social capital on children's reading and mathematics test scores (Altonji and Dunn 1995; Portes and MacLeod 1996; Pong 1997; Roscigno 1998 and 2000; OECD 2001; Parcel and Dufur 2001; Baker, Goesling and LeTendre 2002).

Earlier research of school effects by Coleman (1966) and Jencks et al. (1972) has concluded that the differential effect of schools on student achievement is less than the effect of socioeconomic background. Researchers who examined the effects of expenditure and other resources have found insignificant or inconclusive results (Hauser 1969; Alwin and Otto 1977; Hanushek 1986). This is mainly because earlier studies of school effects often used limited measures of school resources (e.g. expenditures per student), and the models specified at the school level did not adequately reveal the effect of school resources on individual achievement after controlling for differences in student background (Bryk and Raudenbush 1992; Rumberger and Wilms 1992). Thus, the effects of school resources were understated in these earlier studies (Rumberger and Wilms 1992). In addition, according to Heyneman and Loxley (1983), most research on the effect of school characteristics on student achievement is conducted mainly from a few of the world's school systems (mostly in Europe, North America, and Japan). Heyneman and Loxley (1983) explore the diverse influences on pupil achievement in Africa, Asia, Latin America, and the Middle East. This study on low-income countries suggests that the effects of school and teacher quality on academic achievement in primary school are comparatively greater (Heyneman and Loxley 1983). This led to the conclusion that the predominant influence on student learning is the quality of the schools and teachers to which children are exposed.

The school's average socioeconomic status and resources (human and instructional) have been shown to affect educational outcomes in more recent studies that use more appropriate statistical techniques and more detailed measures of school characteristics (Altonji and Dunn 1995; Portes and MacLeod 1996; Pong 1997; Roscigno 1998 and 2000; OECD 2001; Baker, Goesling and LeTendre 2002). Findings from France, United Kingdom, Germany, Russian Federation, Belgium, Mexico and Switzerland reveal a positive relationship between a school's average socioeconomic status and academic achievement (OECD 2001). Evidence from Belgium, Canada, Mexico, and Russian Federation also seems to suggest that students from high schools with more resources seem to outperform those with fewer resources (OECD 2001).

Ream (2003) divided studies on school social capital into those that reflect academically relevant teacher / student interaction and those that reflect school-initiated interaction with parents. His review of literature identified two recent studies by Stanton-Salazar and Dornbusch (1995) and Croninger and Lee (2001) that offered thorough analyses of teacher/student interaction as social capital, arguing that teachers can provide students with direct and convertible sources of educational assistance. Other researchers (Ho and Willms 1996; Parcel and Dufur 2001) have examined the impact of a school's social capital on children's educational outcomes. However, the findings are mixed. In their attempt to examine reading and math test scores, Ho and Willms (1996) found that parents' participation at school had a moderate effect on reading achievement but a negligible effect on mathematics achievement. Parcel and Dufur (2001) found that students whose parents were involved in their schools, irrespective of family socioeconomic status, performed better in academic courses and have less propensity to drop out of high school. On the contrary, students attending schools where the social environment is hampered by numerous social problems have lower reading and math test scores (Parcel and Dufur 2001).

Researchers from the United States have examined the interrelationship between racial composition of the school and academic achievement. Even though the 1966 Coleman report suggests that the achievement of minority students is higher in racially integrated schools, the findings on the effects of ethnic composition on academic achievement are mixed. Gamoran's (1987) analysis of the High School and Beyond data reveal the existence of a significant negative relationship between the proportion of black students and science and vocabulary scores tests but not between the proportion of Latino students and achievement. Evidence in the United States also suggests that segregated minority schools (mainly blacks, Latinos, and Native Americans) are more likely to have fewer material and teacher resources, weaker academic climate, and greater concentrations of low-income, homeless, limited English-speaking and immigrant students than racially diverse schools (Van Hook 2002). On the contrary, racially diverse or schools are characterized by more human and instructional resources, namely qualified, credentialed teachers instructing in their area of expertise, a more rigorous academic climate, and students with higher academic aspirations (Ingersoll 1999).

However, most research on the effect of school characteristics often examined the impact of the school's human, financial (e.g. educational levels of teachers, quality of the schools and teachers, funding resources of the school, etc.), and social capital (e.g. bonds between parents and schools) on student achievement. To the best of my knowledge, only Parcel and Dufur (2001) have attempted to examine the impact of school behavioral problems on academic achievement. They found that students attending schools where the social environment is hampered by numerous social problems have lower reading and math test scores (Parcel and Dufur 2001).

In Malaysia, the literature has paid less attention to the effects of school characteristics on academic achievement. In addition, the literature has paid less attention to whether the effects of school characteristics on academic achievement vary across ethnic groups. With this in mind, this proposed study will explore the possible influences of school characteristics on eighth grade mathematics and science achievement and whether such influences differ between Malay and Non-Malay students using the Third International Mathematics and Sciences Study Repeat Project (TIMMS-R).

Summary

In their attempt to study racial inequality in educational outcomes, stratification researchers in both developed and developing countries have focused on many aspects of educational outcomes. In the United States and Europe, researchers of educational attainment tend to focus on school progression (transition to lower and upper secondary education and college) (e.g. Blake 1985; Lucas 2001), grade completion (e.g. Shavit and Pierce 1991; Warren 1996), middle and high school dropouts (e.g. Pong and Ju 2000), and high school graduation (e.g. Sandefur, McLanahan and Wojtkiewicz 1992). In Malaysia, Thailand, and Vietnam, stratification researchers tend to focus on the completion of primary, secondary, upper-secondary and post-secondary education (e.g. Knodel and Wongwith 1991; Pong 1993, 1996 and 1999; Anh, Knodel, Lam and Friedman 1998). In Kenya, stratification researchers tend to focus on years of school completion (e.g. Gomes 1984). With respect to educational achievement, researchers in the United States and Europe tend to focus on eighth grade mathematics, science, and reading achievement (e.g. Parsons, Adler and Kaczala 1982; Parsons, Kaczala and Meece 1982; Murray and Sandqvist 1990; Catsambis 1994; Downey 1995; Portes and MacLeod 1996; Muller 1998; Roscigno 1998; Zhang 1999; Parcel and Dufur 2001; Mokshein 2002; Sandefur and Campbell 2002). To the best of my knowledge, only three studies, two in the United States (i.e. Portes and MacLeod 1996; Roscigno 1998) and one in

Sweden (i.e. Murray and Sandqvist 1990), attempt to holistically explore how individual, family, and school characteristics affect mathematics and reading achievement.

To date, the bulk of literature in Malaysia is replete with studies on mathematics learning and achievement. While their methods vary, these studies tend to conclude that Non-Malays tend to perform better in mathematics because of the different ways students and parents valued mathematics learning. However, most of these studies were qualitative and exploratory in nature, employing mostly classroom observations and in-depth interviews. Therefore, their findings were far from conclusive, and this dictates caution in generalizing these findings to the larger Malaysian society. In addition, the literature has not paid sufficient attention to science learning and achievement among Malaysian students. To the best of my knowledge, only one researcher (i.e. Mokshein 2002) identifies the factors that influence science achievement. Unlike other studies which employed mostly ethnographic studies and in-depth interviews, the Third International Math and Science Study (TIMSS) of 1999 for Malaysia was employed in the studies of Mokshein (2002). Mokshein's (2002) study found, among other things, that self-concept in science, awareness of the social implications of science, gender, and home educational resources were significantly related to achievement. However, factors such as ethnicity, type of family living arrangement, students' perceived usefulness of the subject, and shadow education were not examined fully in Mokshein's study. Using the same data, this study attempts to fill the gap by investigating inter-ethnic differences in mathematics and science achievement between eighth graders in Malaysia. This study also extends previous research to holistically explore how individual, family, and school characteristics affect mathematics and science achievement of eighth graders in Malaysia.

It seeks to determine whether family SES and school characteristics are more important for some ethnic or gender groups.

Hypotheses

On the basis of these general theoretical orientations and the results of earlier research, the present study proposes to test the following hypotheses.

1. With respect to the effect of ethnicity, I follow Lim and Saleh's (2002) and Lim's (2003) line of reasoning to hypothesize that Non-Malay students will have significantly higher scores in mathematics and science than Malay students, controlling for other relevant factors.

Family characteristics (type of family living arrangement, family size, parent's education, and number of books and educational objects at home) as a mediating process:

2. Interethnic achievement gaps are due primarily to family characteristics (type of family living arrangement, family size, parent's education, and number of books and educational objects at home). After controlling for family characteristics, achievement gaps between Malay and Non-Malay students will be greatly reduced or eliminated.

Shadow education, student's perceived importance of the subject, and students' educational expectations as a mediating process:

3. Interethnic achievement gaps are due primarily to shadow education, student's perceived importance of the subject, and students' educational expectations. After controlling for shadow education, student's perceived importance of the

subject, and students' educational expectations, achievement gaps between Malay and Non-Malay students will be greatly reduced or eliminated.

School context as a mediating process:

4. Interethnic achievement gaps are due primarily to differences in school characteristics. After controlling for school characteristics, achievement gaps between Non-Malays and Malay natives and between immigrants and Malay natives will be greatly reduced or eliminated.

Possible interaction effects between ethnicity and family characteristics, student's perceived importance of the subject, and shadow education:

5. Since the government's preferential policies, which give favorable treatment to Malays, might have increased the direct costs of education for Non-Malays, I hypothesize that the positive effects of parent's education, number of educational objects at home, and number of books at home on mathematics and science achievement will be greater among Non-Malay students.
6. Following Pong's (1996) findings that Malay students residing in single-parent families are at a greater risk of leaving school, I hypothesize that the negative effect of living in a single-parent, stepparent, or nonparent household on mathematics and science achievement will be greater among Malay students.
7. Since the preferential education policies constitute a type of external support for Malay children's education, this may have reduced the intra-familial competition for educational resources among Malays siblings, thereby weakening the family size effect on educational attainment among Malay students (Pong 1999). Following Pong's (1999) findings, I hypothesize that the

negative effect of family size on mathematics and science achievement will be greater among Non-Malay students.

8. Following the findings of Lim and Saleh (2002) and Lim (2003) that Chinese student's success in mathematics achievement is assumed to be directly related to the unique traditional Chinese culture of education, I hypothesize that the positive effects of needing to do well in mathematics and science to please their parents on mathematics and science achievement will be greater among Non-Malay students. I also hypothesize that the positive effects of needing to do well in mathematics and science to please themselves on mathematics and science achievement will be greater among Non-Malay students.
9. Following Pong's (1993) findings that Malays are more likely than Chinese and Indians to complete primary school and move on to secondary school, I hypothesize that the positive effects of needing to do well in mathematics and science to get into desired secondary school or university on mathematics and science achievement will be greater among Malay students.
10. Following the findings of Lim and Saleh (2002) and Lim (2003) that Chinese parents are more likely than Malay parents to send their children for extra classes in mathematics, I hypothesize that the positive effect of shadow education on mathematics and science achievement will be greater among Non-Malay students.

These hypotheses are reflected in figures 1 and 2.

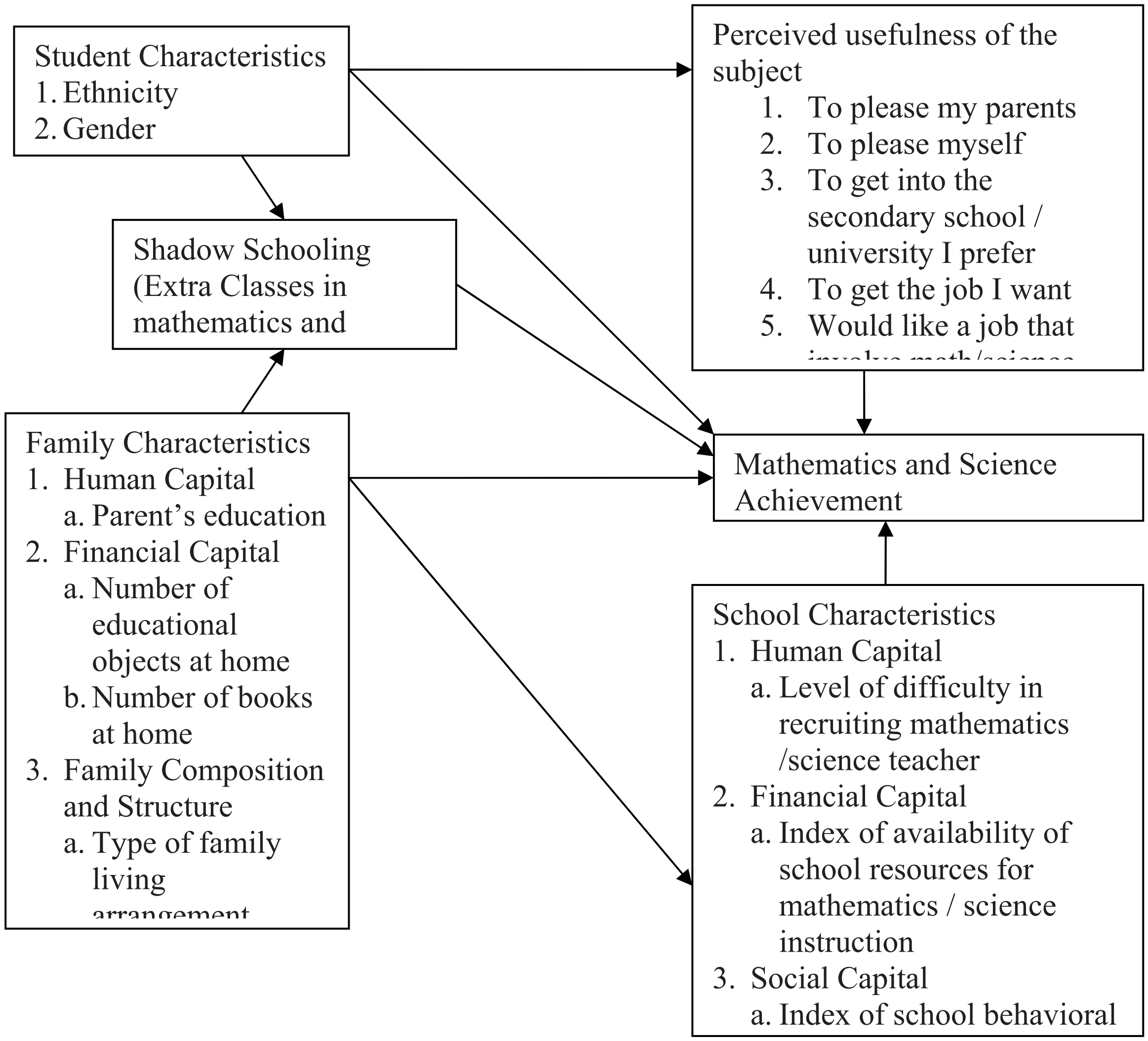

Figure 1 Conceptual Model: Mediating Effects

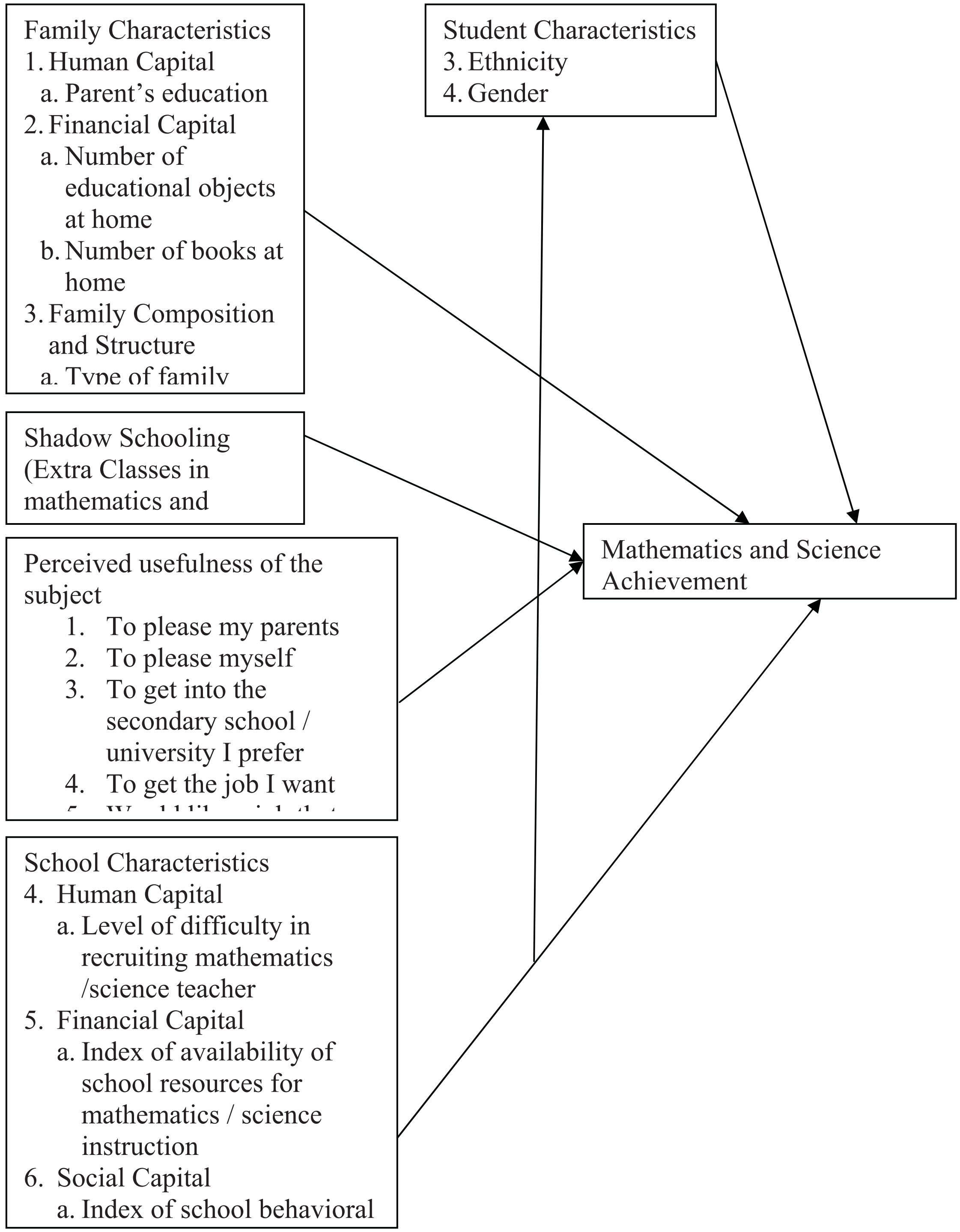

Figure 2 Conceptual Model: Moderating Effects

CHAPTER III

DATA AND METHODOLOGY

Data

The overall objective of this study is fourfold: (1) whether there are any ethnic differences (i.e. Malay and Non-Malay) in mathematics and science achievement among eighth graders in Malaysia; (2) what roles of various factors proposed play in the literature in accounting for mathematics and science achievement of Malay and Non-Malay students; (3) whether there are any ethnic differences (i.e. Malay and Non-Malay) in mathematics and science achievement after controlling for students' background (ethnicity, gender, family socioeconomic status, family composition and structure), school-focused parent-child interactions, student's perceived usefulness of the subject and educational expectations, shadow schooling and school characteristics; and (4) whether the students' background (ethnicity, gender, family socioeconomic status, family composition and structure), school-focused parent-child interactions, student's perceived usefulness of the subject and educational expectations, shadow schooling and school characteristics vary across Malay and Non-Malay students. Multilevel or hierarchical models will be used to address the above-mentioned questions. The analysis will be performed on the cohort of grade eight Malaysian students who participated in the Third International Mathematics and Sciences Study (TIMMS-1999) conducted in 2000. The dataset was downloaded from the public domain of Boston College at http://timss.bc.edu/timss1999.html.

Introduction

TIMSS was conducted by the Dutch-based International Association for the Evaluation of Educational Achievement (IAE) and the International Assessment of Educational Progress (IAEP) (Mullis et al. 2000). TIMSS 1999 was organized by the IAE and managed by the International Study Center at Boston College, under the auspice of Michael O. Martin and Ina V.S. Mullis. This assessment resulted from the American education community's need for reliable and timely data on the mathematics and sciences achievement of American students compared to that of students in other countries (Gonzalez and Miles 2001). Malaysia participated in the TIMSS 1999 study with 37 other countries. Extensive information from students, teachers, and school principals about mathematics and science curricula, instruction, domestic situations, and school characteristics and policies were collected in TIMSS 1999. The main purpose of TIMSS 1999 was to assess students' mathematics and sciences achievement and factors connected to students' achievement in 38 countries (Gonzalez and Miles 2001). Twenty three of these countries already had participated in the eighth grade assessment of TIMSS 1995 (Gonzalez and Miles 2001). In each country, nationally representative samples of approximately 3,500 students were assessed in about 150 schools (Gonzalez and Miles 2001). The target population for the 1999 assessment was 13 and 14 years old students, which in Malaysia meant students of the grade 8 (Form 2) (Gonzalez and Miles 2001).

Participants

This study included 5,579 eighth grade students and 150 schools in Peninsular Malaysia. TIMSS 1999 used a two-stage sampling procedure to ensure a nationally representative sample of students (Gonzalez and Miles 2001). Prior to sampling, schools in the sampling frame – a comprehensive national list of all eligible schools -- were assigned to 28 predetermined strata. At the first sampling stage, using a systematic probability-proportional-to-size (PPS) technique, approximately 150 schools were randomly selected from all secondary schools in each participating country. The probability of selection for a school was proportional to the number of eighth grade students in the school. Stratification by region and urbanization was used to ensure that urban and rural schools in all 11 states were represented. A total of 28 strata was used. According to the TIMSS 1999 international report, there were essentially three reasons for stratifying: 1) to produce reliable estimates for the sub-national domains, 2) to improve the sampling efficiency and thereby improving the reliability of national estimates, and 3) to ensure that different parts of the population are appropriately represented in the sample (Gonzalez and Miles 2001). At the second sampling stage, one or two eligible classrooms of eighth grade students within each sampled school were randomly selected (Gonzalez and Miles 2001). Since mathematics and science are core subjects in Malaysian schools, all students in the selected classrooms were included in the study (Gonzalez and Miles 2001). The sampling for Malaysian schools in the TIMSS 1999 study was conducted by Statistics Canada using the school-sampling frame provided by the Ministry of Education, Malaysia (Gonzalez and Miles 2001).

Instruments

The development of the TIMSS instrument was documented in a technical report (Gonzalez and Miles 2001). The TIMSS 1999 study employed three types of instrument: the Achievement Test Booklets, Student Questionnaire Main Survey (SQ2), and the Science Teacher Questionnaire Main Survey (TQS2).

Achievement Test

Testing was designed so that no one student took all items, which would have required more than three hours (Gonzalez and Miles 2001). The test consisted of science and mathematics questions assembled in eight booklets, each requiring 90 minutes to complete. Each participating student was assigned one booklet only, and the items were rotated through the booklets so that each item would be answered by a representative sample of students. For Malaysia, the tests and questionnaires that were originally prepared in English were translated into the Malay language. A series of verification checks were conducted to ensure the comparability of the translations.

About one-fourth of the items were in the free-response format, requiring students to generate and write their own answers. The rest were multiple choice items. Correct answers to most questions were worth one point, while the free-response items were evaluated for partial credit, with each fully corrected answer being awarded two points (Gonzalez and Miles 2001). This study used students' scores available in TIMSS 1999 data files, namely the first plausible values of the overall or composite mathematics and science scores.

Survey Questionnaires

TIMSS 1999 included a broad array of questionnaires to collect data on the educational context for student's achievement (Gonzalez and Miles 2001). Benchmark coordinators and National Research Coordinators (NRCs) from participating countries, with assistance from their curriculum experts, provided detailed information on the organization, emphases, and content coverage of the mathematics and science curriculum. In the Student's Main Survey Questionnaire, students answered questions pertaining to their personal characteristics such as home background characteristics, attitudes towards mathematics and science, their academic self-concept, and out-of-school activities, and classroom activities. In the Teacher's Main Survey Questionnaire, the mathematics and science of the sampled students responded to questions pertaining to instructional practices, teaching emphases on topics in the TIMSS curriculum framework, professional training and education, and their views on mathematics and science. The school principals responded to questions about school staffing and resources, mathematics and science course offerings, and teacher support. This study used data from the Student's Main Survey Questionnaire and the Teacher's Main Survey Questionnaire.

Data Collection and Procedures

While country representatives came together to work on instruments and procedures, they were each responsible for conducting TIMSS 1999 in their own countries (Gonzalez and Miles 2001). The NRCs were responsible for a range of important activities, including: 1) meeting with other NRCs and project staffs to review data collection instruments and procedures, 2) conducting all national sampling activities, 3) translating the tests, questionnaires, and administration manuals to the language of the instruction in the country, 4) ensuring that the tests and questionnaires were administered, 5) recruiting individuals to score the free-response question in the test, and 6) checking the data files before them to the IEA Data Processing Center in Hamburg. For Malaysia, the national center for TIMSS 1999 was the Educational Policy Planning and Research Division (EPRD) in the Ministry of Education (MOE), and its Director, Dr. Ani Zakaria was the NRC.

Three data files in the TIMSS 1999 were used: 1) the School Characteristics file (BCGMYSM2), 2) the Student Background File (BSGMYSM2), and 3) the Student-Teacher Linkage file (BSTMYSM2). Values from the derived variables were computed and irrelevant items were detected before the files were merged to create a new data file that contains mathematics and science scores and the selected variables. This process was done using SAS for Windows.

The TIMSS 1999 data are particularly well-suited for my analysis not only because it is representative of the Peninsular Malaysian population, but also because it is one of the few surveys which collected extensive information from students, parents, teachers, and school principals. Basic indicators reflecting student's attitudes towards mathematics and science, student's expectations for finishing school, and parental and peer influences were also recorded. According to the TIMSS 1999 international report, Malaysia was placed 16th in mathematics and 22nd place in science in the scoreboard for 38 countries (Mullis et al. 2000). The average mathematics and science score for Malaysian eighth graders was 519 and 492 respectively, slightly above the international average of 487 and 488 respectively (Mullis et al. 2000). The analysis is limited to students whose information for ethnicity, gender, family and school characteristics, their perceived importance of the subject, and shadow education is valid. The final analysis sample consists of 5,562 students. Only coefficients with $p <= 0.05$ are regarded as significant.

Measurement of Variables

Dependent Variable

There are two outcome variables, namely the first plausible values in mathematics and science. They are measured by IRT (Item Response Theory) scale score based on five mathematics and science tests. Each student received one of the five test batteries; thus individual raw test scores are not comparable. Based on Item Response Theory, TIMSS provides five plausible values. I presented results for the first value, which according to Pong (1998), has been widely used for international comparison. Supplemental analyses were also performed on other four plausible values to see if they yielded similar results. The use of the other four plausible values produced almost identical results (see Appendix for details). The units of analysis in this study are individuals and schools.

Independent Variables

Five groups of variables were used as predictors of mathematics and science achievement in this study: 1) student personal characteristics (ethnicity and gender), 2) family background factors (parent's education, number of books and educational objects at home, the type of family living arrangement, and family size), 3) student's perceived importance of the subject and educational expectations, 4) shadow education (extra classes in mathematics and science), and 5) school characteristics.

The first group describes the basic characteristics of students. These variables include ethnicity and gender. The *ethnicity* variable is constructed from responses to two questions. The first is "Were you born in Malaysia" and the second is "Do you speak the language of the test (i.e. Malay) at home?" It is indicated by one dummy variable: Malay and Non-Malay students, with Malay students serving as the reference category. Malay students are Malaysia-born students who speak the language of the test (i.e. Malay) at home. Non-Malay students are Malaysia-born students who do not speak the language of the test at home. Respondent's *gender* was dummy coded for females (0, reference) and males (1).

The second group describes the family characteristics of students. Three indicators were used to represent the amount of monetary and non-monetary family resources available to the student, namely parent's education, the number of books and the number of educational objects at home. Because the father's and mother's levels of educational attainment are highly correlated, this study analyzed the effects of education based on which parent had the higher level of education, which was dummy-coded into college and university education, secondary education, and no more than primary education with no more than primary education serving as the reference. *The number of books and educational objects* at home was based on the list of items student reported they have at home, such as books, a calculator, a computer, a study desk, dictionary, reference books and video. In addition to the measures of family SES, this study accounted for family composition and structure. *The type of family living arrangement* was dummy-coded into two-parent families, mother-only families, father-only families, stepparent families and a residual category (students living in non-parent households, containing all types of family structures not mentioned above), with two-parent families serving as the reference category. *Family size* is measured by the total number of people living with the student. This indicator is a proxy of the number of siblings the child has. Research in a wide range of other countries documented a negative relationship between sibship size and educational achievement (Blake 1981).

The third group describes *student's perceived usefulness of the subject* and *educational expectations. Student's perceived usefulness of the subject* was approximated by five Likert-scale variables that asked students how and why they themselves considered it important to do well in mathematics and science. Students were asked to state their agreement with the following statements: 1) I need to do well in mathematics / science to please my parents; 2) I need to do well in mathematics / science to please myself; 3) I need to do well in mathematics / science to get into the secondary school / university I prefer; 4) I need to do well in mathematics / science to get the job I want; and 5) I would like a job that involved using mathematics / science. For each statement, students responded on a four-point scale from 1= strongly disagree to 4 = strongly agree. *Student's educational expectations* are measured by a single item that asked about the level of education the student expected to complete. The survey asked students: "How far in school do you expect to go?" It is indicated by dummy variables for up to secondary education (reference) (1), two-year college (2), first degree and higher than first degree (3).

The fourth group measures *shadow schooling*. This is a continuous variable tapping the number of hours the student reported spending on extra classes in mathematics and sciences before or after school in a week.

The final group of variables is measures of *school characteristics*. This study examined three aspects of school characteristics, namely the school's human, financial, and social capital. The school's human capital is represented by the variable measuring the *level of difficulty in recruiting mathematics / science teachers*. Answers to the question were provided on a four-point scale from 1 = none, 2 = a little, 3 = some, and 4 = a lot. The school's financial capital is represented by the variable indicating the *adequacy of a school's material resources for mathematics / science instruction*. Answers to this question were provided on a three-point scale from 1 = low resources, 2 = medium resources, and 3 = high resources. The school's social capital is represented by the *type of school community*, the *level of parents' involvement in school*, one other index indicating the *severity of school's behavioral problems*, and the *school's racial context*, measured as the percentage of students who are Malay in a school. The *type of school community* is indicated by dummy variables for schools located in rural, suburban, and urban area. The level of *parents' involvement in school activities* on achievement is represented by three variables: 1) Parents assisting as teacher aides in the classrooms; 2) Parents assisting teacher on trips, and 3) Parents volunteer for school programs. To capture the extent of *school behavioral problems* on achievement, a factor score has been created from the variables measuring school behavioral problems: 1) Severity of arriving late at school, 2) Severity of absenteeism, 3) Severity of skipping class, 4) Severity of violating dress code. 5) Severity of classroom disturbance, 6) Severity of cheating, 7) Severity of profanity, 8) Severity of vandalism, 9) Severity of theft, 10) Severity of intimidation of students, 11) Severity of injury of students, 12) Severity of intimidation of teachers, and 13) Severity of injury to teachers (alpha 0 .919). Answers to this question were provided on a three-point scale from 1 = not a problem, 2 = minor problem, and 3 = serious problem.

Weight Variables

The use of appropriate sampling weights ensures that the different subgroups that make up the sample are appropriately and proportionally represented in the computation of population estimates. In this study, house weight (HOUWGT) was entered at the student-level and generalized to the school-level. This variable was computed as follows: HOUWGT = TOTWGT * [N / Sum of TOTWGT], where TOTWGT = Total student weight for student i, and N = sample size. The sum of this variable over all schools within each country adds up to the sample size for the particular country (Gonzalez and Miles 2001). The use of this weight variable is therefore appropriate when the actual sample size was used in the analyses.

Analytical Strategy

To test the hypotheses developed previously, the multilevel or hierarchical linear modeling (HLM) technique was used. A total of five nested HLM models was estimated for each dependent variable. Since the principal concern of this analysis is to examine the inter-ethnic differences in mathematics and science achievement of the eighth graders in Malaysia, the analysis began by including ethnicity in the first (baseline) model. The second model added gender. The third model added measures of family characteristics. The fourth model added shadow education, measures of student's perceived usefulness of the subject, and student's educational expectations. And the final model added school's characteristics. Each successive model built on the previous model.

The following models were used in examining the effects of student and school-level variables on students' mathematics and science achievement:

Model 1:

Level 1:

$$ACH_{MATH/SCIENCE} = B0 + B1 * ETHNICITY + R$$

Level 2:

B0 = G00 + U0

B1 = G10,

where B0 = mean of school, G00 = grand mean for all the 150 schools under study, R = within school or student-level random effects, and U0 = between school random effects.

Model 2:

Level 1:

$$ACH_{MATH/SCIENCE} = MODEL1 + B2 * GENDER + R$$

Level 2:

B0 = G00 + U0

B1 = G10

B2 = G20

Model 3:

Level 1:

$$ACH_{MATH/SCIENCE} = MODEL2 + B3 * FAMILY\_CHARACTERISTICS + R$$

Level 2:

B0 = G00 + U0

B1 = G10

B2 = G20

B3 = G30

Model 4:

Level 1:

$$ACH_{MATH/SCIENCE} = MODEL3$$
$$+ B4 * SHADOW\_ED \& USEFULNESS / EXPECTATIONS + R$$

Level 2:

B0 = G00 + U0

B1 = G10

B2 = G20

B3 = G30

B4 = G40

Model 5:

Level 1:

$$ACH_{MATH/SCIENCE} = MODEL4 + B5 * SCHOOL\_CHARACTERISTICS + R$$

Level 2:

B0 = G00 + U0

B1 = G10

B2 = G20

B3 = G30

B4 = G40

B5 = G50

Since the New Economic Policy (NEP) discriminated positively in favor of the Malay population and against the Non-Malays, this raises the possibility that family characteristics (especially family SES) may work in different ways to influence the mathematics and science achievement across racial / ethnic groups. Indeed, earlier studies (Hirschman 1979; Pong 1993; Suddha 1997) have pointed out the differential effects of NEP across racial / ethnic groups. Therefore, two separate but identical multilevel regression models—one for Malays and the other for Non-Malays were estimated for Models 3, 4, and 5 because one of my research questions is to determine whether the effect of family characteristics, students' perceived usefulness of the subject, shadow education, and school characteristics associated with mathematics and science achievement differ among Malays and Non-Malays.

Individuals within a particular group may be more likely to be affected by the structural conditions of that group, therefore, they may be more similar to one another than individuals in other groups (Bryk and Raudenbash 1992; Kreft and De Leeuw 1998). Schools can also provide an appropriate context for examining educational achievement because they structure individuals' potential acquaintance and increase the likelihood of creating and maintaining peer groups. From a contextual point of view, this means introducing a multilevel approach in which individuals (the first level of analysis) are nested in different contexts (the second level), and variables from the two levels can be jointly analyzed in a unified framework (Bryk and Raudenbash 1992; Kreft and De Leeuw 1998) to test the hypothesized relationships. Since the 1999 TIMSS has a hierarchical structure, with students clustered within schools, the multilevel or HLM technique is a suitable statistical methodology for this study (Bryk and Raudenbash 1992). In other words, multilevel modeling allows the simultaneous examination of the effects of independent variables measured on two different levels—students and schools. Because the standard errors are adjusted to account for the clustering of students in schools, a multilevel modeling approach allows for dependence among students within schools and provides estimates that enabled us to describe variations in the outcome variables that were due to this clustering (Bryk and Raudenbash 1992). As such, the effects of the independent variables could be estimated without being distorted by the similarity of students within a school (Bryk and Raudenbash 1992). In addition, multilevel modeling allows the partition of variance of the outcome variables into within –school and between-school components and then allows one to explain each component by the independent variables measured at the relevant level (Bryk and Raudenbash 1992). Therefore, this study will use multilevel modeling to estimate the relationship between the independent variables and the outcome variables.

CHAPTER IV

ANALYSIS

Introduction

This chapter presents the results of the analyses and interpretations of the results. It is organized around the research questions presented in Chapter 1. All results reported are based on the final estimations of fixed and variance components with robust standard errors in the HLM analyses.

Interclass Correlation: Is the variation in Mathematics and Science Achievement Greater among Students Within or between Schools in the Population?

At the first stage of the analysis, results from the null (fully unconditional) models were used to determine how much of the variation in the students' mathematics and science scores was at the student-level (within schools) and school-level (between schools). For this analysis, no variables were introduced at both the student and school levels.

Mathematics Achievement

The following null model was used to estimate the proportion of variance in mathematics achievement within and between schools.

Level 1:

Mathematics Achievement = B0 + R;

Level 2:

B0 = G00 + U0;

The proportion of variance in mathematics achievement within and between schools is computed as follows:

Proportion of student-level or within school variance

= 2713.81 / (2713.81 +3,713.98) * 100 % = 42.22 %

Proportion of school-level or between school variance

= 3,713.98 / (2713.81 +3,713.98) * 100 % = 57.78 %

This suggests that about 42 percent of the variance in mathematics achievement lies within schools, while the remaining 58 percent lies between schools, meaning that the variability in mathematics achievement is greater between schools than within schools, and therefore there is plenty of school-level variance to model.

Science Achievement

The following null model was used to estimate the proportion of variance in science achievement within and between schools.

Level 1:

Science Achievement = B0 + R;

Level 2:

B0 = G00 + U0;

The proportion of variance in science achievement within and between schools is computed as follows:

Proportion of student-level or within school variance

= 3,195.30 / (3,195.30 +3,546.67) * 100 % = 47.39 %

Proportion of school-level or between school variance

= 3,546.67 / (3,195.30 +3,546.67) * 100 % = 52.61 %

This suggests that about 47 percent of the variance in science achievement lies within schools, while the remaining 53 percent lies between schools. This means that the variability in science achievement is greater between schools than within schools, thus there is plenty of school-level variance to model.

Table 4: Partitioning of Variances Between-School and Within-School in the Null Model

Panel A: Mathematics Achievement					
Fixed Effects	Coefficient	S.E.	T-ratio	d.f.	P-value
Intercept	520.12	5.03	103.44	149	< 0.0001
Random Effects	Variance Component	S.E.	Z-value	P-value	
Tau (School-level)	3713.98	437.61	8.49	< 0.0001	
Sigma Square (Student-level)	2713.81	52.1	52.09	< 0.0001	
Panel B: Science Achievement					
Fixed Effects	Coefficient	S.E.	T-ratio	d.f.	P-value
Intercept	492.84	4.69	105.11	149	< 0.0001
Random Effects	Variance Component	S.E.	Z-value	P-value	
Tau (School-level)	3195.3	380.21	8.4	< 0.0001	
Sigma Square (Student-level)	3546.67	68.08	52.09	< 0.0001	

Descriptive Statistics

Before discussing the results of the multivariate analysis, it is important to note some differentials observed in the original sample grade eight (Form 2) Malaysian students. Table 5 presents descriptive statistics of Malays and Non-Malays. On average, Non-Malays have higher mathematics and science test scores than Malays. Comparing the two groups on the basis of parent’s education, the TIMSS 1999 data suggest that the parents of Non-Malays are relatively more educated than the parents of Malays. While 45.36% and 22.28% of the Non-Malay’s parents possess at least a secondary education, the same figures for Malays are 39.88% and 20.48%, respectively. Similarly, while 39.64% of the Malay’s parents possess at most a primary education, 32.36% of the Non-Malay’s parents had comparable education. Table 5 also shows that Non-Malays have slightly more educational objects and books at home than Malays, while the reverse is true when we look at family size. Comparing the two groups on the basis of family living arrangement, the TIMSS 1999 data indicate a slightly higher percentage of Non-Malay students coming from two-parent families, while the reverse is true when we look at single parent and stepparent families. While 90.01% of the Non-Malay students come from two-parent families, the same figure for Malays is 87.81%. While 7.07% of the Malay students come from mother-only families, the same figure for Non-Malay students is 5.58%. While 3.23% of Malay students come from stepparent families, the same figure for Non-Malay students is 2.30%. Table 5 also indicates that Non-Malays tend to spend more time in extra mathematics and science classes. Comparing the two groups on the basis of their educational expectations, the TIMSS 1999 data suggest that Malay students have higher educational expectations than Non-Malay students. While 66.77% of the

Malay students expect to go to university, the same figure for Non-Malays is 60.04%. While 20.34% of the Non-Malay students expect to study until secondary school, the same figure for Malay students is 16.05%. While 19.26% of Non-Malay students expect to earn a college diploma, the same figure for Malay students is 17.19%. The school resources available for mathematics and science instruction is about the same in schools attended by Malays and Non-Malays. Similarly, the level of difficulty in recruiting mathematics and science is about the same in schools attended by Malays and Non-Malays. Schools attended by Non-Malays have relatively higher levels of parental involvement than schools attended by Malays. On the contrary, schools attended by Malays have relatively more behavioral problems than schools attended by Non-Malays. Table 5 also documents that a somewhat higher percentage of Non-Malays attend schools in urban areas. While 52.07% of Malay students attend schools in rural areas, the same figure for Non-Malay students is 28.67%. While 17.16% of Malay students attend schools in suburban areas, the same figure for Non-Malay students is 15.26%. While 30.78% of Malay students attend schools in urban areas, the same figure for Non-Malay students is 56.08%.

Table 5: Variable Descriptions, Means, and Standard Deviations, TIMSS 1999

	All (N = 5,562)		Malay (N = 3,340)		Non-Malay (N = 2,222)	
Variables	Mean	Std	Mean	Std	Mean	Std
Mathematics	520.50	80.77	502.47	71.07	547.72	86.47
Science	492.85	82.54	484.12	77.10	506.27	88.04
Sex						
Female (ref.)	55.23%		54.67%		56.08%	
Male	44.77%		45.33%		43.92%	
Family Human Capital						
Up to Primary (ref.)	36.73%		39.64%		32.36%	
Up to Secondary	42.07%		39.88%		45.36%	
University	21.20%		20.48%		22.28%	
Family Financial Capital						
# of Educational Objects	1.49	0.63	1.37	0.64	1.68	0.56
# of Books at Home	2.70	1.11	2.64	1.10	2.80	1.13
Family Social Capital						
Family Size	6.92	3.16	7.19	3.30	6.51	2.90
Family Living Arrangement						
Two parent (ref.)	88.69%		87.81%		90.01%	
Biological mother only	6.47%		7.07%		5.58%	
Biological father only	1.38%		1.32%		1.49%	
Stepparent families	2.86%		3.23%		2.30%	
Non-parent households	0.59%		0.57%		0.62%	
Extra classes in mathematics	1.89	1.06	1.79	1.03	2.04	1.10
Extra classes in science	1.66	0.99	1.60	0.97	1.76	1.02
Reasons for doing well in mathematics						
To please my parents	1.50	0.65	1.35	0.53	1.74	0.74
To please myself	3.42	0.69	3.44	0.70	3.40	0.68
To get into the secondary school / university I prefer	1.42	0.58	1.31	0.51	1.57	0.65
To get the job I want	1.45	0.60	1.38	0.57	1.55	0.64
Would like job that involve math	3.25	0.70	3.24	0.70	3.25	0.70

Table 5: Cont.

Reasons for doing well in science						
To please my parents	1.53	0.66	1.37	0.53	1.76	0.75
To please myself	3.37	0.70	3.39	0.71	3.35	0.69
To get into the secondary school / university I prefer	1.48	0.63	1.39	0.58	1.61	0.69
To get the job I want	1.55	0.67	1.48	0.63	1.66	0.71
Would like job that involve science	3.29	0.72	3.31	0.71	3.26	0.74
Student's educational expectations						
Up to Secondary (ref.)	17.76%		16.05%		20.34%	
Some College	18.16%		17.19%		19.26%	
University	64.08%		66.77%		60.04%	
School Financial Capital						
Index of available school resources for math instructi	2.12	0.52	2.15	0.49	2.06	0.55
Index of available school resources for science instru	2.14	0.53	2.17	0.52	2.11	0.55
Level of difficulty in recruiting mathematics teachers	2.58	1.21	2.52	1.25	2.66	1.15
Level of difficulty in recruiting science teachers	2.58	1.19	2.55	1.22	2.64	1.13
School Social Capital						
Parents assisting as teacher aides in the classroom	29.34%		27.04%		32.81%	
Parents volunteer in school programs	98.81%		98.80%		98.83%	
Parents assisting teacher on trips	56.35%		51.95%		62.96%	
Index of school social problem	28.89	7.51	28.70	7.45		7.59
Rural Schools (ref.)	42.72%		52.07%		28.67%	
Suburban Schools	16.40%		17.16%		15.26%	
Urban Schools	40.88%		30.78%		56.08%	

Multivariate analysis

Determinants of Mathematics Achievement

All Ethnic Groups Combined

Results reported in Model 1 of Table 4 show that the expected mathematics achievement of Non-Malays is significantly higher than that of Malay. The addition of gender and family characteristics in Models 2 and 3 did not affect the statistical significance of ethnicity but slightly changed its magnitudes. Model 3 shows that controlling for ethnicity, gender, and other family characteristics, the number of books at home is positively associated with expected mathematics achievement. Model 3 also shows that controlling for ethnicity, gender, and other family characteristics, on average students from stepfamilies have significantly lower mathematics achievement than those from two-parent families.

The addition of shadow education, student's perceived importance of mathematics, and student's educational expectations in Model 4 did not affect the statistical significance of ethnicity and gender but changed their magnitude. As can been seen from the table, controlling for ethnicity, gender, and other family characteristics, needing to do well in mathematics to please their parents and themselves, as well as to get into their desired secondary school or university and to get the job they want, and wanting a job involving mathematics are positively related to expected mathematics achievement. Student's educational expectations is also positively and significantly related to mathematics achievement. However, Malay-NonMalay differentials in mathematics achievement are reduced when measures for shadow education, student's perceived importance of mathematics, and student's educational expectations were controlled. This suggests that shadow education, student's perceived importance of mathematics, and student's educational expectations have a mediating effect on the relationship between ethnicity and mathematics achievement. Similarly, controlling for shadow education, student's perceived importance of mathematics, and student's educational expectations mediates the effects of the number of educational objects at home and living in a stepparent family on mathematics achievement.

Interestingly, the effect of gender becomes significant in Model 4, suggesting that male students perform significantly better in mathematics than female students when shadow education, student's perceived importance of mathematics, and student's educational expectations are taken into account. Supplementary analyses were undertaken using forward stepwise method to determine which of these groups of the variables (i.e. shadow education, student's perceived importance of mathematics, and student's educational expectations) are responsible for the male advantage in mathematics achievement. These supplementary analyses suggest that male advantage in mathematics achievement is suppressed by student's perceived importance of mathematics. In other words, the lack of a gender gap between boys and girls in mathematics achievement can be largely attributable to their differences in perceived importance of mathematics (especially needing to do well in mathematics to get into their desired secondary school or university and to get the job they want, and wanting a job involving mathematics). As research in the United States (i.e. Catsambis 1994; Muller 1998; Parsons, Adler and Kaczala 1982; Parsons, Kaczala and Meece 1982; Zhang 1999) has shown, gender difference appears primarily in attitudes toward mathematics learning.

The addition of school characteristics in Model 5 did not affect the statistical significance of ethnicity, gender, parent's education, shadow education, student's perceived importance of mathematics, and student's educational expectations, and other family characteristics but slightly changed its magnitude. Controlling for ethnicity, gender, shadow education, students' perceived importance of the mathematics, and student's educational expectations, and other family characteristics, students' mathematics achievement decreases with the difficulty in recruiting mathematics teacher. There is, however, no evidence that school resources available for mathematics instruction, as well as the levels of parents' involvement in schools and school behavioral problems are significantly related to mathematics achievement. This is not surprising in light of research by Domina (2005) showing the effect of parents' involvement on adolescent's academic achievement as non-significant after school and family background are taken into account. Students from schools located in urban areas perform better in mathematics than students from schools located in rural areas. There is, however, no evidence that students from schools located in suburbs have significantly higher mathematics scores than student from schools located in rural areas. Controlling for ethnicity, gender, shadow education, students' perceived importance of the mathematics, and student's educational expectations, and other family characteristics, students' mathematics achievement decreases with the percentage of Malay students in a school. The results in Model 5 also suggest that the effect of gender on mathematics achievement is mediated to some extent by school characteristics. Gender differentials in mathematics achievement are reduced when school characteristics are introduced in Model 5.

The effects of the number of books at home and stepparent families in Models 4 are less than in Model 3. Such a reduction would be indicative of a mediating effect of shadow education, student's perceived importance of mathematics, and student's educational expectations. A further decline in the coefficients of the number of books at home and stepparent families in Model 5 is also indicative of a mediating effect of school characteristics.

Table 6: Determinants of Mathematics Achievement, TIMSS 1999

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Ethnicity					
Malay (ref.)					
Non-Malay	17.6665***	17.6420***	17.0010***	13.2664***	13.5834***
Sex					
Female (ref.)					
Male		1.1530	2.173	5.2344**	4.9577**
Family Human Capital					
Up to Primary (ref.)					
Up to Secondary			-0.1506	-2.0051	-2.1766
College and University			-0.6893	-2.8037	-3.1834
Family Financial Capital					
# of Educational Objects			0.9587	0.2431	0.0287
# of Books at Home			6.7988***	5.7282***	5.6271***
Family Social Capital					
Family Size			-0.2217	-0.3854	-0.3845
Family Living Arrangement					
Two parent (ref.)					
Biological mother only			2.283	3.0233	2.7313
Biological father only			9.2185	6.8307	6.1863
Stepparent families			-19.5706***	-18.4373***	-17.3220***
Non-parent households			15.1913*	14.9158*	15.0150*
Extra classes in mathematics				0.829	0.7235
Reasons for doing well					
To please my parents				9.3171***	9.1522***
To please myself				9.6928***	9.7421***
To get into the secondary school / university I prefer				5.4036**	5.5487**
To get the job I want				3.5345**	3.5227**
Would like job that involve math				8.6867***	8.3914***

Note: * Significant at < 0.05, ** Significant at < 0.01, *** Significant at < 0.001

Table 6: Cont.

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Student's educational expectations					
Up to Secondary (ref.)					
Some College				10.5747***	10.7824***
University				21.8999***	22.2131***
School Financial Capital					
Index of available school resources for math instruction					2.7290
School Human Capital					
Level of difficulty in recruiting mathematics teachers					-8.3381**
School Social Capital					
Parents assisting as teacher aides in the classroom					0.9071
Parents volunteer in school programs					6.3738
Parents assisting teacher on trips					5.6430
Index of school social problem					-0.1640
Type of School Community					
Rural Schools (ref.)					
Suburban Schools					17.4311
Urban Schools					47.3430***
Constant	513.34***	512.83***	496.51***	396.25***	387.33***
-2 Log Likelihood	60469.70	60469.10	58777.70	57505.30	56179.60

Note: * Significant at < 0.05, ** Significant at < 0.01, *** Significant at < 0.001

By ethnicity

The results in Models 3, 4 and 5 of Table 7 suggest that the effects of the number of books at home, living in a stepfamily, student's perceived importance of mathematics, and students' educational expectations differ by ethnicity. The number of books at home is positively associated with mathematics achievement for both Malays and Non-Malays. The positive effect of the number of books at home is stronger among Non-Malay students. However, after controlling for school characteristics, the positive effect of the number of books at home is slightly stronger among Malay students. It is plausible that attending schools with adequate material and instructional resources, fewer behavioral problems, as well as schools that encourage parental participation affected Malay students' mathematics achievement positively. This is in part due to the fact that school contexts (e.g., curriculum and organization) are more likely to reflect specific (educational) expectations of the Malay students, who are the majority segments of society (Ogbu and Matute-Bianchi 1986). Living in a stepparent family has negative effects on mathematics achievement for both Malays and Non-Malay students. Even though both Malay and Non-Malay students from stepfamilies have significantly lower mathematics achievement than their counterparts from two-parent families, the negative effect of stepfamily on mathematics achievement is stronger among Malay students, suggesting that living in a stepparent family makes the most difference for Malay students and less for Non-Malay students.

Results reported in Models 4 and 5 show that student's perceived importance of mathematics has positive effects for both Malays and Non-Malay students even though the effect size is different. Controlling for gender and other family characteristics, the positive effects of needing to do well in mathematics to please their parents is about three times stronger among Non-Malay students. A possible reason for the substantially larger effect of needing to do well in mathematics to please their parents is that Non-Malay students are more likely to adhere to parental beliefs about the value of mathematics education. Likewise, controlling for gender and other family characteristics, the positive effect of needing to do well in mathematics to please themselves is about two times stronger among Non-Malay students. On the contrary, the positive effect of needing to do well in mathematics to get into their desired secondary school or university is slightly stronger among Malay students. Likewise, the positive effect of wanting a job involving mathematics is about 1.5 times stronger among Malay students. It is plausible that needing to do well in mathematics to get into their desired secondary school or university and wanting a job involving mathematics makes the most difference for Malay students and less for Non-Malay students because their opportunities for secondary and tertiary education and subsequent employment prospects were expanded under the preferential policy that discriminated positively in favor of them. This might have altered Malays' self-confidence and perceived importance of mathematics. Models 4 and 5 also show that student's educational expectations is positively and significantly related to mathematics achievement for both Malays and Non-Malay students. The positive effect of student's educational expectations is stronger among Non-Malay students for college education and slightly stronger among Malay students for university education. Thus there is reason to suppose that expecting a college education makes the most difference for Malay students and less for Non-Malay students.

The level of difficulty in recruiting mathematics teacher has negative effects on mathematics achievement for both Malays and Non-Malay students even though the effect is significant among Malay students and the effect size is different among ethnic groups. Controlling for gender, family characteristics, and student's perceived importance of the subject, the effect of the level of difficulty in recruiting mathematics teacher is stronger among Non-Malay students. It appears that the level of difficulty in recruiting mathematics teacher makes the most difference for Non-Malay students and less for Malay students. The results in Model 5 also indicate that both Malays and Non-Malay students from schools located in urban areas perform better in mathematics than their counterparts from schools located in rural areas. Controlling for gender, family characteristics, and student's perceived importance of the subject, the positive effect of urban school location is about 1.15 times stronger among Non-Malay students. It appears that the type of school community makes the most difference for Non-Malay students and less for Malay students. Controlling for ethnicity, gender, shadow education, students' perceived importance of the mathematics, and student's educational expectations, and other family and school characteristics, students' mathematics achievement decreases with the percentage of Malay students in a school for both Malay and Non-Malay students. It appears that the percentage of Malay students in a school makes the most difference for Non-Malay students and less for Malay students.

The decline in the coefficients for the number of books at home and living in a stepparent family in Model 4 provide support for the mediating effects of shadow education, student's perceived importance of mathematics, and student's educational expectations for both Malay and Non-Malay students. The further declines in the coefficient for these variables in Model 5 are also indicative of a mediating effect of school characteristics for both Malay and Non-Malay students.

Table 7: Determinants of Mathematics Achievement by Ethnicity, TIMSS 1999

Variables	Model 3		Model 4		Model 5	
	Malay	Non-Malay	Malay	Non-Malay	Malay	Non-Malay
N	3,340	2,222	3,340	2,222	3,340	2,222
Sex						
Female (Ref.)						
Male	2.05	1.474	5.074**	4.877	5.390**	3.842
Family Human Capital						
Up to Primary (Ref.)						
Up to Secondary	-1.293	1.15	-3.315	-0.43	-3.665	-0.55
College and University	1.968	0.136	0.161	-2.812	-0.998	-2.11
Family Financial Capital						
# of Educational Objects	-1.799	4.005	-1.555	4.196	-2.103	3.866
# of Books at Home	6.822***	7.259***	5.789***	5.916***	5.796***	5.490***
Family Social Capital						
Family Size	-0.281	-0.091	-0.388	-0.363	-0.343	-0.406
Family Living Arrangement						
Two-parent Families (Ref.)						
Biological Mother Only	1.344	-0.731	2.79	-0.025	2.968	-1.241
Biological Father Only	10.673	7.149	8.791	4.017	7.822	4.333
Stepparent Families	-19.972***	-18.499*	-19.831**	-16.890*	-18.279**	-17.033*
Non-parent Families	19.225	-3.838	19.354	-8.111	19.978*	-5.38
Extra Classes in Mathematics			0.645	1.041	0.531	0.657
Student's perceived importance of Mathematics						
To please my parents			4.393*	11.677***	4.336*	11.188***
To please myself			7.287***	13.011***	7.202***	13.128***
To get into the secondary school / university I prefer			5.015**	4.579*	5.064**	4.648*
To get the job I want			2.38	4.001	2.399	3.647

Note: * Significant at < 0.05, ** Significant at < 0.01, *** Significant at < 0.001
The coefficient for Male in Model 2 for Malay and Non-Malay are 0.9994 and 0.8809. Both of these did not reach significance.

Table 7: Cont.

Variables	Model 3		Model 4		Model 5	
	Malay	Non-Malay	Malay	Non-Malay	Malay	Non-Malay
Would like job that involve math			9.241***	6.275**	9.106***	5.782*
Students' Educational Expectations						
Up to Secondary (Ref.)						
Some College			8.586**	11.483**	9.359**	10.925**
University			21.941***	21.535***	22.573***	21.742***
School Financial Capital						
Index of available school resources for math instruction					6.021	9.372
School Human Capital						
Level of difficulty in recruiting mathematics teachers					-7.351*	-8.777*
School Social Capital						
Parents assisting as teacher aides in the classroom					5.002	-1.992
Parents volunteer in school programs					12.267	37.293
Parents assisting teacher on trips					-0.644	2.238
Index of school behavioral problems					-0.214	-0.145
Type of School Community						
Rural Schools (Ref.)						
Suburban Schools					15.742	1.43
Urban Schools					30.866**	34.918***
Percent Malay					-33.938*	-61.952**
Constant	496.97***	501.78***	412.01***	394.00***	420.30***	386.19***
-2 Log Likelihood	35,192.30	23,713.80	34,306.80	23,320.90	33,571.20	22,691.90

Note: * Significant at < 0.05, ** Significant at < 0.01, *** Significant at < 0.001
The coefficient for Male in Model 2 for Malay and Non-Malay are 0.9994 and 0.8809. Both of these did not reach significance.

Determinants of Science Achievement

All Ethnic Groups Combined

The lack of ethnic differences in science achievement could be a consequence of educational expansion and science-based curricular innovations under the aegis of the National Economic Policy that offers both Malay and Non-Malay students more hands on opportunity to manipulate scientific and technological devices. This means that the preferential policies contributed to the development of favorable attitudes towards science learning for both Malay and Non-Malay students. It is equally likely that since the medium of instruction in all public schools is changed from English to Malay following the implementation of the New Economic Policy, this might make science learning easier for Malay students.

In Table 8 the results from Model 2 show that when controlling for ethnicity, male students perform significantly better in science achievement than female students. As research by Zhang (1999) has shown, male students perform significantly better in science achievement than female students. The addition of family characteristics in Model 3 does not affect the statistical significance of gender but slightly changes its magnitude. Model 3 shows that controlling for ethnicity, gender, and other family characteristics, students whose parents have at least a secondary education perform significantly better in science achievement than students whose parents have primary education. Model 3 also shows that the number of books at home is positively associated with science achievement and that there is a negative and significant relationship between family size and science achievement. As research in Arab States (Egypt, Jordan, Lebanon, Syria, and Tunisia), Central and Eastern Europe (Hungary, Latvia, Lithuania, Macedonia, Moldova, Romania, Russia, Serbia, and Slovak Republic), Central Asia (Armenia), Asia Pacific (Australia, Hong Kong, Japan, New Zealand, Singapore, and Taiwan), Latin America (Chile), and North America (United States), Western Europe (Belgium, Cyprus, England, Israel, Italy, Netherlands, Norway, and Sweden), West Asia (Iran), and Sub-Saharan Africa (Botswana and South Africa) has shown, students from small families outperformed students from large families in science achievement (Ma 2008).

The addition of shadow education, measures of student's perceived importance of science, and student's educational expectations in Model 4 does not affect the statistical significance of gender and other family and school characteristics but changes their magnitudes. Controlling for ethnicity, gender and other family characteristics, the need to do well in science to please their parents and themselves, and wanting a job involving science are positively related to science achievement. Interestingly, students who expect to go to a two-year college have significantly lower scores in science than students who expect to finish secondary school education. The most plausible explanation is that some major fields of study in a two year college do not require competency in science. Students who expect to complete a first degree or higher perform significantly better in science than students who expect to complete secondary school.

A comparison of the coefficients for gender between Models 2, 3 and 4 suggests that the impact of gender on science achievement increases when the type of family living arrangement, shadow education, student's perceived importance of science, student's educational expectations, and school characteristics are taken into account.

Therefore, it is logical to assume that the type of family living arrangement, shadow education, student's perceived importance of science, student's educational expectations, and school characteristics have crucial impacts on gender differences in science achievement. The fact that boys generally do better in science than girls can be largely attributable to their differences in the type of family living arrangement, perceived importance of science, educational expectations and school characteristics. There is also no evidence that higher school material resources for science instruction are associated with higher science achievement.

The addition of school characteristics in Model 5 does not affect the statistical significance of ethnicity, gender, and other family characteristics but slightly changes their magnitude. The effect of needing to do well in science to get the job they want becomes statistically significant in Model 5. Controlling for ethnicity, gender, shadow education, student's perceived importance of science, and student's educational expectations, and other family characteristics, students' science achievement decreases with the difficulty in recruiting science teacher. Students from urban schools perform better in science than students from rural schools. There is, however, no evidence that students from schools located in suburbs have significantly higher science scores than student from schools located in rural areas. Controlling for ethnicity, gender, shadow education, students' perceived importance of the mathematics, and student's educational expectations, and other family and school characteristics, students' science achievement decreases with the percentage of Malay students in a school for both Malay and Non-Malay students.

The reduction in the coefficients for parent's education and the number of books at home in Model 4 provides support for the mediating effects of shadow education, student's perceived importance of science, and student's educational expectations on the relationship between these variables and science achievement. The further decline in the coefficients for parent's education and the number of books at home in Model 5 also provides support for the mediating effect of school characteristics.

Table 8: Determinants of Science Achievement, TIMSS 1999

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Ethnicity					
Malay (Ref.)					
Non-Malay	2.644	2.246	2.112	0.081	-0.89
Sex					
Female (Ref.)					
Male		18.460***	19.465***	21.466***	21.372***
Family Human Capital					
Up to Primary (Ref.)					
Up to Secondary			3.991*	3.288	1.932
College and University			13.071***	11.587***	10.432***
Family Financial Capital					
# of Educational Objects			-1.287	-0.92	-0.605
# of Books at Home			6.698***	5.975***	5.807***
Family Social Capital					
Family Size			-0.895**	-0.940**	-0.896**
Family Living Arrangement					
Two-parent Families (Ref.)					
Biological Mother Only			1.944	2.532	3.008
Biological Father Only			-7.196	-6.703	-6.659
Stepparent Families			1.451	2.311	2.132
Non-parent Families			-13.956	-13.676	-14.235
Extra Classes in Science				-1.345	-1.6
Students' Perceived Usefulness of Science					
To please my parents				5.316***	5.289***
To please myself				2.824*	2.572*
To get into the secondary school / university I prefer				0.822	0.909
To get the job I want				3.374	3.631**
Would like a job that involve science				6.226****	5.760***
Students' Educational Expectations					
Up to Secondary (Ref.)					
Some College				-7.916**	-8.348**
University				8.604***	9.051***

Note: * Significant at < 0.05, ** Significant at < 0.01, *** Significant at < 0.001

Table 8: Cont.

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
School Financial Capital					
Index of available school resources for science instruction					2.192
School Human Capital					
Level of difficulty in recruiting science teachers					-7.977**
School Social Capital					
Parents assisting as teacher aides in the classroom					0.0198
Parents volunteer in school programs					17.848
Parents assisting teacher on trips					0.344
Index of school behavioral problems					-0.13
Type of School Community					
Rural Schools (Ref.)					
Suburban Schools					2.928
Urban Schools					27.056***
Percent Malay					-24.869
Constant	491.88***	483.71***	469.67***	425.52***	434.93***
-2 Log Likelihood	61,957.10	61,847.00	60,111.60	58,887.10	56,729.80

Note: * Significant at < 0.05, ** Significant at < 0.01, *** Significant at < 0.001

By ethnicity

As can be seen in Models 3, 4 and 5, Malay students from non-parent households have significantly lower science achievement than their counterparts from two-parent families. The results in Models 3, 4 and 5 of Table 9 show that the effects of gender, parent's education, the number of books at home, family size, student's perceived importance of science, and student's educational expectations depend on ethnicity. The results in Models 2, 3, 4 and 5 show that male students perform significantly better in science achievement than female students. The effect of gender on science achievement is stronger for Malay students.

When the analyses are disaggregated by ethnicity, parent's education is positively related to both Malay and Non-Malay students' science achievements. As can be seen in Models 3, 4 and 5, both Malay and Non-Malay students whose parents have university degrees perform significantly better in science than their counterparts whose parents have primary education. The positive effect of parent's education is stronger among Malay students, thereby suggesting that parent's education makes the most difference for Malay students and less for Non-Malay students. Therefore, it is possible that Malay parents with college and university education are more likely to instill in their children the importance of being proficient in science, but also as the majority segments of society, they understand the processes of learning and possess important practical knowledge of how school systems work. Consequently, Malay students with college and university educated parents have potentially greater access to informal parental help.

The number of books at home is positively associated with science achievement for both Malays and Non-Malays. The positive effect of the number of books at home is stronger among Non-Malay students. However, after controlling for school characteristics, the positive effect of the number of books at home is slightly stronger among Malay students. As is the case with mathematics achievement, it is plausible that attending schools with adequate material and instructional resources, fewer behavioral problems, as well as schools that encourage parental participation affected Malay students' science achievement positively. This is in part due to the fact that school contexts (e.g., curriculum and organization) are more likely to reflect specific (educational) expectations of the Malay students, who are the majority of society (Ogbu and Matute-Bianchi 1986).

The results in Models 3, 4, and 5 indicate that science achievement decreases with family size for both Malay and Non-Malay students, even though the negative effect of family size on science achievement is stronger among Non-Malay students. Therefore, it appears that the preferential education policy may have increased the intra-familial competition for educational resources among Non-Malay siblings.

A comparison of the coefficients for the number of books at home between Models 3, 4 and 5 indicates that shadow education, student's perceived importance of science, student's educational expectations, and school characteristics exert a mediating effect on the relationship between the number of books at home and science achievement. A comparison of the coefficients for non-parent households between Models 3, 4 and 5 indicates that the exclusion of shadow education, measures of student's perceived importance of science, student's educational expectations, and school characteristics exerts a suppressing effect on the relationship between non-parent household and science achievement for Non-Malay students.

Model 4 shows that controlling for gender, shadow education, student's educational expectations, and other family characteristics, the need to do well in science to please their parents and themselves are positively related to science achievement for Non-Malay students. The need to do well in science to get the job they want is positively related to science achievement for Malay students. Wanting a job involving science is positively related to science achievement for both Malay and Non-Malay students. Models 4 and 5 show that Malay students who expect to complete a first degree or higher perform significantly better in science than their counterparts who expect to complete secondary school. Model 5 shows that Non-Malay students who expect to complete a first degree or higher perform significantly better in science than their counterparts who expect to complete secondary school. The positive effect of expecting to complete a first degree or higher is slightly stronger among Non-Malay students. However, as is the case in the number of books at home, the positive effect of expecting to complete a first degree or higher is slightly stronger among Malay students after school characteristics are taken into account. As is the case with mathematics achievement, it seems that attending schools with adequate material and instructional resources, fewer behavioral problems, as well as schools that encourage parental participation affected Malay students' science achievement positively. This is in part due to the fact that school contexts (e.g., curriculum and organization) are more likely to reflect specific (educational) expectations of the Malay students, who are the majority segments of society (Ogbu and Matute-Bianchi 1986). Models 4 and 5 show that Malay students who expect to complete a two-year college degree perform significantly worse in science than their counterparts who expect to complete secondary school. The most plausible explanation is that some major fields of study in a two year college do not require competency in science. Students who expect to complete a first degree or higher perform significantly better in science than students who expect to complete secondary school.

The results in Model 5 suggest that the difficulty in recruiting science teacher is associated with lower science achievement for Malays. Both Malay and Non-Malay students from schools located in urban areas have significantly higher science scores than their counterparts from schools located in rural areas. As research by Zhang (1999) has shown, students from schools located in urban areas perform significantly better in science achievement than students from schools located in rural areas. The positive effect of urban school location is stronger among Non-Malay students. Likewise, the negative effect of the percentage of Malay students in a school on science achievement is greater among Non-Malay students. As is the case with mathematics achievement, it appears that the percentage of Malay students in a school makes the most difference for Non-Malay students and less for Malay students.

The analyses of both the Malay and Non-Malay samples in Model 4 provide support for the mediating effects of shadow education, student's perceived importance of science, and student's educational expectations. This is evidenced by a decline in the coefficients for parent's education, the number of books at home, and family size between Models 3 and 4 indicates that exert a mediating effect on the relationship between parent's education and science achievement. There is also indication of a mediating effect of school characteristics. The coefficients for the above-mentioned variables are further reduced when school characteristics are included in Model 5

.

Table 9: Determinants of Science Achievement by Ethnicity, TIMSS 1999

Variables	Model 3		Model 4		Model 5	
	Malay	Non-Malay	Malay	Non-Malay	Malay	Non-Malay
	3,340	2,222	3,340	2,222	3,340	2,222
Sex						
Female (ref.)						
Male	20.161***	16.366***	22.753***	18.105***	23.229***	16.960***
Family Human Capital						
Up to Primary (ref.)						
Up to Secondary	4.282*	3.093	4.158*	1.804	2.8670	0.040
University	14.399***	13.681***	13.603***	11.483**	12.281***	10.065**
Family Financial Capital						
# of Educational Objects	-1.123	-0.168	-0.6610	0.396	-0.6130	0.867
# of Books at Home	6.948***	7.575***	6.236***	6.401***	6.212***	5.746***
Family Social Capital						
Family Size	-0.836**	-1.067**	-0.875**	-1.055**	-0.869**	-0.967**
Family Living Arrangement						
Two parent (ref.)						
Biological mother only	-2.224	5.641	-1.811	5.7880	-1.269	5.834**
Biological father only	0.691	-18.877*	0.404	-17.6050	0.0010	-16.950
Stepparent families	6.242	-10.798	6.306	-8.727	6.743	-10.045
Non-parent households	-25.573**	11.010	-27.074**	11.675	-29.085**	12.750
Extra classes in science			-1.819	-0.764	-1.885	-1.350
Reasons for doing well						
To please my parents			2.167	7.481**	2.257	7.416**
To please myself			0.003	8.406**	0.137	7.335**
To get into the secondary school / university I prefer			-0.788	3.516	-0.927	3.577
To get the job I want			4.638**	1.665	4.814**	1.844
Would like job that involve science			6.461**	5.792**	6.382**	4.818*

Note: * Significant at < 0.05, ** Significant at < 0.01, *** Significant at < 0.001

Table 9: Cont.

Variables	Model 3		Model 4		Model 5	
	Malay	Non-Malay	Malay	Non-Malay	Malay	Non-Malay
	3,340	2,222	3,340	2,222	3,340	2,222
Student's educational expectations						
Up to Secondary (ref.)						
Some College			-12.410***	-5.075	-11.501**	-7.589*
University			7.596**	9.004**	9.065**	7.882**
School Financial Capital						
Index of available school resources for science instruction					-0.814	4.519
School Human Capital						
Level of difficulty in recruiting science teachers					-7.057**	-7.454
School Social Capital						
Parents assisting as teacher aides in the classroom					4.677	0.702
Parents volunteer in school programs					32.722	12.151
Parents assisting teacher on trips					3.439	5.076
Index of school social problem					-0.216	0.131
Rural Schools (ref.)						
Suburban Schools					3.733	5.107
Urban Schools					28.697***	44.029***
Constant	466.28***	467.97***	436.88***	399.41***	416.55***	380.86***
-2 Log Likelihood	36,047.20	24,225.30	35,253.40	23,779.90	34,035.70	22,820.00

Note: * Significant at < 0.05, ** Significant at < 0.01, *** Significant at < 0.001
The coefficient for Male in Model 2 for Malay and Non-Malay are 18.9780 and 15.8769. Both of these are significant at < 0.001

CHAPTER V

SUMMARY, DISCUSSION, AND CONCLUSIONS

Summary

The purpose of this study was to examine inter-ethnic differences in mathematics and science achievement in Malaysia. It sought to determine the extent to which theoretical propositions of the structural and cultural perspectives developed to explain achievement differences in the United States were applicable in Malaysia. The empirical work of this study was based on the cohort of eighth grade students who participated in the Third International Mathematics and Sciences Study Repeat Project (TIMMS-R). Collectively, these results are consistent with previous findings in the literature. The analyses showed that Malay-Non-Malay gaps in mathematics achievement were reduced, but not totally explained, when measures for family and school characteristics, student's perceived importance of mathematics and educational expectations, and shadow schooling were controlled. The case of Malaysia also suggests that approaches to state action that can be applied elsewhere in the Asian Pacific Rim.

The findings of this study indicate that part of the Malay-Non-Malay gaps in mathematics and science achievement can be explained by the structural perspective, as evidenced by the women's disadvantage in these achievements. It also appears that the residual mathematics achievement differences between Malay and Non-Malay students can be explained by culture and discrimination. This work should not be taken as evidence that ethnicity causes the Malay-Non-Malay gaps in mathematics achievement. Unmeasured factors such as the more direct and explicit proxies of cultural values (i.e. religion, personal discipline, and premium on industry / persistence, respect of elders and authority, and so forth) and neighborhood characteristics may affect adolescents' mathematics and science achievement.

Discussion

The hypothesis about Malay's disadvantage was supported for mathematics achievement. The multilevel modeling analyses showed that Non-Malay students performed significantly better in mathematics achievement than Malay students, even after controlling for family and school characteristics as well as student's perceived importance of mathematics. This finding resonates with earlier studies (e.g. Lim and Saleh 2002; Lim 2003) on the mathematics achievement of two primary schools in Malaysia.

The hypothesis about family characteristics (i.e., the type of family living arrangement, family size, parent's education, and the number of books and educational objects at home) as a mediating process was not confirmed. Controlling for family characteristics (the type of family living arrangement, family size, parent's education, and the number of books and educational objects at home) only slightly reduced the Malay-Non-Malay gaps in mathematics achievement.

The hypothesis about shadow education, student's perceived importance of the subject, and student's educational expectations as a mediating process was supported for mathematics achievement. Malay-Non-Malay differentials in mathematics achievement were reduced, but not totally explained, when measures for shadow education, student's perceived importance of the subject, and student's educational expectations were controlled. Thus shadow education, student's perceived importance of the subject, and student's educational expectations, though influential, cannot fully explain the observed Malay-Non-Malay differences in mathematics achievement. This provides partial support for the cultural perspective. In other words, Malay-Non-Malay differences in mathematics achievement can be attributable to the cultural differences between Malay and Non-Malay students. The hypothesis about school context as a mediating process was supported. Malay-Non-Malay differentials in mathematics achievement were further reduced when measures for the school financial, social and human capital were controlled.

The hypothesis about the possible interaction effects between ethnicity and family characteristics was supported for both mathematics and science achievement. Results indicated that while there are similarities with research findings in Western and Asian countries, there are other issues that are ethnic specific. With respect to mathematics achievement, the effects of family financial capital (number of books at home), family living arrangement (living in a stepparent family), student's perceived importance of mathematics, and school characteristics (the level of difficulty in recruiting mathematics teachers) depend on ethnicity. With respect to science achievement, the effects of family human capital (parent's education), family financial capital (the number of books at home), family social capital (family size), and family living arrangement (living in a nonparent household) depend on ethnicity. Overall, the results suggest that the structural and cultural perspectives work differently for Malay and Non-Malay students. Thus it seems that the government's preferential policies which give favorable treatment to Malays might alter the effects of these family and school characteristics among the Malay and Non-Malay populations. The effects of the number of books at home on both mathematics and science achievement are stronger for Non-Malay students than for Malay students. It is plausible that the preferential education policies might have increased the direct costs of being in school for Non-Malays, thereby increasing the family SES effect on children's educational attainment and achievement among the Non-Malay populations. However, the effect of the number of books at home is partially attributable to the school context. The positive effect of the number of books at home is slightly stronger among Malay students after controlling for school characteristics. This is due to the fact that school contexts (e.g., curriculum and organization) are more likely to reflect specific (educational) expectations of the Malay students, who are the majority segments of society (Ogbu & Matute-Bianchi, 1986). Therefore, attending schools with adequate material and instructional resources, fewer behavioral problems, as well as schools that encourage parental participation affected Malay students' mathematics and science achievements positively. The effect of parent's education on science achievement is stronger for Malay students than for Non-Malay students. As the majority segments of society, Malay parents with college and university education understand the processes of learning and possess important practical knowledge of how school systems work and are therefore more able to offer informal parental help to their children. The effect of family size on science achievement is stronger for Non-Malay students than for Malay students. Thus it seems that the preferential education policies that provide educational support to Malay families might have reduced the direct costs of being in school for Malays but increased the intra-familial competition for educational resources among Malays siblings (Pong 1999). The effect of living in a stepparent family on mathematics achievement is stronger among Malay students. This can be partly attributable to the fact that Malay students are more likely than their Chinese counterparts to grow up in stepparent families because the Malay culture regards divorce as a realistic and normal and there are less negative stereotypes about stepfamilies.

The hypothesis about the possible interaction effects between ethnicity and student's perceived importance of the subject was supported for both mathematics and science achievements. The effects of wanting to do well in mathematics / science to please their parents or themselves were larger among Non-Malay students. Thus it seems that Non-Malay students are more likely to adhere to parental beliefs about the value of mathematics education. The effects of wanting to do well in mathematics to get into their preferred secondary school / university and wanting a job involving mathematics were greater among Malay students. Thus it seems that the preferential policy has remarkably changed Malays' self-image, self-confidence, and attitude towards schooling, and these changes are the key elements for their school success (Pong 1999). A corollary of this finding is that successive cohorts of Malay students have experienced relative improvements in family income and parental schooling that affect student's perceived importance of the subject (McEwan 2007). Over time, Malay students may have altered their values and attitudes toward education and thus have realized their government's expectations that they can do as well as their Non-Malay classmates when they are presented with the right incentives (Pong 1993). However, the hypothesis about the possible interaction effects between ethnicity and shadow education was not supported.

Step-parent upbringing has a significant negative effect on mathematics achievement. Students from stepparent families performed significantly worse in mathematics achievement than students from two-parent families. This academic disadvantage is greater among Malay students. Indeed, Cherlin (1978) characterized remarriage as an “incomplete” institution, mainly because there is no consensus about when is it appropriate for a stepparent to discipline a stepchild. This finding suggests that Malay students have more difficulty than Non-Malay students adjusting to the entrance of a stepparent family. A study by Zill (1994) suggests that children in stepfamilies are likely to be disadvantaged in terms of the number of siblings in the household with whom they must compete for those resources. In addition to reduced access to parental time and monetary resources, other plausible explanations for the continued educational disadvantages faced by these adolescents in stepfamilies include parental conflict, stresses associated with divorce, remarriage, and residential moves, lower levels of parental involvement and educational expectations, and poorer school attendance (Ginther and Pollak 2004). Malay students living in non-parent households performed significantly worse in science achievement than their counterparts from two-parent families. This finding resonates with Teachman’s (2008) research that found that undetermined living arrangement is linked to lower levels of school engagement.

In addition to educational expansion and science-based curricular innovations under the aegis of the National Economic Policy, the lack of ethnic differences in science achievement can be attributable to the survey instrument. After an extensive examination of TIMSS instrument, Jianjun Wang provided four reasons why not all free-response scores reflect student science achievement. Foremost among Wang’s concern is that

TIMSS does not allow a range of answers to its free-response item. Instead, the answer type is a nominal variable, with different categories for different responses. This creates a predicament with regard to how to assign higher or lower scores to different student responses.

A second concern expressed by Wang is that although the two-digit coding scheme can be used to circumvent the general problem of differentiating answer types in the item score, it is in no way suited for science scoring because not all science items have only one correct response. If the preceding example demonstrates that the TIMSS scoring missed a correct answer, some TIMSS items were potentially confusing because they listed more than one correct choice. Wang emphasized this concern by giving an example that not all science items have only one correct response: “The water level in a small aquarium reaches up to a mark A. After a large ice cube is dropped into the water, the cube floats and the water level rises to a new mark B. What will happen to the water level as the ice melts? Explain your reasoning.” In Wang’s view, this question can be unanswerable if no additional information about the experimental temperature and the potential significant effect of evaporation are provided. Therefore, according to Wang, it is possible for the TIMSS scoring to miss a correct answer and some TIMSS items were potentially confusing because they listed more than one correct choice.

A third concern expressed by Wang is that not all TIMSS scores are grounded in students' levels of cognitive development. Wang emphasized this concern by giving an example in a third / fourth grade science test: “The Sun is bigger than the Moon, but they appear to be about the same size when you look at them from the Earth. Why is this?” In this example, Wang’s concern was that since many third- and fourth-graders use "higher" and "farther" interchangeably, they will receive a score of zero if they “refer to the sun being higher up than the moon” when attempting to describe the difference in distances in the sky.

A final concern expressed by Wang is that even though TIMSS is the only IEA project that covered mathematics applications in science, not all TIMSS items are free of misconceptions or reflect collaboration between mathematics and science educators. Wang emphasized this concern by giving an example in a seventh / eighth grade science test: “A chemist mixes 3.75 milliliters of solution A with 5.625 milliliters of solution B to form a new solution. How many milliliters does this new solution contain?” In this example, Wang pointed out that the item writer simply assumed that the volume is additive when any two solutions are mixed. In this example, Wang made an important point that many middle-schoolers would not have the relevant background to think so deeply about the item. He went on to mention that such poorly conceived mathematics problems could lead students to develop misconceptions in science.

Conclusions

The Malay’s disadvantage in mathematics achievement persists even after controlling for possible indirect effects of culture (e.g., student’s perceived usefulness of the subject and educational expectations). There are significant policy implications that follow from these results.

Ethnic differentials in educational attainment and achievement have been characterized as a longstanding issue facing public education in Malaysia. The long-term implication of this is that individuals who lack aptitude in these areas will be increasingly disadvantaged in terms of occupational and social mobility. Since there has been increased recognition of the mathematical knowledge and skills, it seems quite likely that the discrepancies in mathematics achievement may contribute to socioeconomic disparity among ethnic groups (Mokshein 2002). The results of this study suggest a pressing need for more effective polices that seek to minimize the undesirable consequences of ethnic discrepancies in mathematics and science achievement.

The analyses showed that male students performed significantly better in mathematics and science achievement than females students. Educational policies could be designed to generate positive attitudes toward mathematics and science among female students (especially among Malay female students). Efforts aimed at enhancing women's representation and involvement in mathematics and science education should be continued. These policies will be crucial to minimize gender disparities in mathematics and science achievement in Malaysia. Student's motivation and their perceived importance of the subject also affect their mathematics and science achievement. This underlines the importance of educational policies that can foster stronger dispositions among female students toward mathematics and science. The difference between male and female students in performance in science is highly relevant for policy makers. Their performance at school and their perceived importance of the subject can have a significant influence on their further education and occupation pathways. These, in turn, can have an influence not only on individual career and income prospects, but also on the broader effectiveness with which human capital is developed and utilized in Malaysia. Therefore, affirmative action programs that use gender as one factor among many in decision-making would seem to be a viable solution to attract female students who would normally not pursue a degree in mathematics and science and to promote success of female students' in science and engineering.

Different types of family living arrangement can have important implications on educational equality. Living in stepparent families and non-parent households has a significant negative effect on science achievement, especially among Malay and male students. Since the analyses revealed that school context can buffer the negative effects of step-parenthood on mathematics achievement, government policy deliberations must include sound educational policies that specifically take into account the school characteristics and family background characteristics of students to minimize the undesirable educational and occupational outcomes associated with such living arrangement. Because of the cross-sectional nature of the data, the findings reported here must be interpreted with caution for policy purposes and they do require further exploration once longitudinal data are available, which can help to sort out the causal order and processes linking living arrangement to mathematics and science achievement.

Difficulty encountered in recruiting mathematics / science teachers have implications on mathematics / science achievement as well. It is therefore likely that policy measures directed at increasing the numbers, preparation, knowledge, motivation, ability of mathematics and science teachers, ensuring that classrooms are staffed with qualified mathematics and science teachers are critical to reducing the persistent educational inequality in Malaysia.

The analyses revealed that students from urban schools outperformed students from rural schools in both mathematics and science achievement. Efforts aimed at providing greater financial aid to improve the human and instructional resources of poverty-stricken rural schools should be continued. This would allow rural schools to hire more qualified teachers, to have smaller classes, and to generally improve the quality of schools and teachers. Another avenue of reform is to generate positive attitudes towards mathematics and science among students (especially among Malay female students). These policies will be crucial to reduce inequality in educational opportunities and educational outcomes in Malaysia.

The analyses also revealed that the racial/ethnic composition of schools matters for mathematics and science achievement in Malaysia. The larger negative effects of of the percentage of Malay students in a school for Non-Malay can also be used to make a case for greater racial/ethnic integration in schools. A corollary of this finding is that the achievement of minority students is higher in racially integrated schools (Coleman 1966).

The government has a role to play in aiding students from disadvantaged families and to try to improve their mathematics and science achievement. Public education efforts should focus on addressing the needs of individuals and families that fall under the category of reconstituted families or stepfamilies. As suggested by Annette Lareau (1987 and 1992), it is imperative for the Malaysian government to find ways to enhance the academic motivation of working-class students and help working-class parents to reorient their educational values and aspirations for their children. These include instructing teachers about how to deal with students from disadvantaged families as well as teaching them how to implant in the mind of students the importance of having a strong family ties that can provide assistance for needy students. These policies will be crucial for a country like Malaysia that has been attempting to minimize the wealth inequality among ethnic groups. The critical concern is how to employ effective means to improve student's motivation and to generate positive attitudes toward mathematics and science learning among Malay students.

Overall, the results suggest that the Malaysian educational system needs to invest in approaches that address aspects of attitudes and learning behaviors in relation to mathematics, particularly for Malay students. This may have implications for the initial training of teachers, as well as for the professional development for teachers, which underlines the importance for schools and teachers to be able to respond individually not only to differences in student abilities, but also in relation to ethnic and gender differences as well as the characteristics of students as learners and their approaches to learning. Hopefully the results of this study will help the Ministry of Education (MOE), schools, teachers, and parents to identify ways to improve student's achievement in mathematics and science and in formulating policies pertaining to resource allocation in the improvement efforts in mathematics and science education.

Future Research

Interpretation of these results, however, should be understood in light of the limitations of the study. First, the effects of family size on academic achievement pose several difficulties of measurement as well as statistical estimation and inference (Eloundou-Enyegue and Williams 2006). The relevant size of a child's family may be straightforward where families are nuclear but it becomes ambiguous in settings where families are large, polygamous, and extended (Lloyd and Gage-Brandon 1994).

Second, besides parental education, the TIMSS 1999 survey does not collect data on other aspects of family resources such as parental occupation and family income.

However, several indicators can be used to approximate the amount of monetary and non-monetary family resources available to the student. One is the number of books at home. Another is the number of educational objects, which is based on the list of items students reported they have at home such as a calculator, a computer, a study desk, dictionary, reference books and video. The number of books and educational objects at home are admittedly imperfect proxies for family SES. Therefore, researchers designing educational surveys in Malaysia should consider including measures of family income and parental occupation.

Third, gender, students' perceived usefulness of the subject and educational expectations are used as indirect proxies for culture. Therefore, researchers designing educational surveys in Malaysia should consider including more direct and explicit proxies of cultural values such as religion, personal discipline, and premium on industry / persistence, respect of elders and authority, and so forth. This would allow future studies to discover whether Malays and Non-Malays differed in these values and whether and how these cultural values can serve as intervening factors to influence academic achievement. The availability of longitudinal data may also help future researchers to examine whether ethnic differences in the educational outcomes persisted in the second and later generations.

Finally, researchers designing educational surveys in Malaysia should consider including neighborhood characteristics such as quality of housing, ethnic composition, education, and so forth. This would allow future studies to discover whether and how these neighborhood characteristics can serve as intervening factors to influence academic achievement.

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APPENDIX A

ETHNICITY AND ACADEMIC ACHIEVEMENT BY MALAYSIAN EIGHTH GRADE STUDENTS

Overall, the supplemental analyses performed on the four other plausible values are consistent with the first plausible values (see Table A1). As is the case with the first plausible values, estimates based on the four other plausible values reveal that the expected mathematics achievement of Non-Malays is significantly higher than that of Malay. Estimates based on the four other plausible values also indicate that male students perform significantly better in mathematics than female students when other variables are included in the analysis.

For plausible value specific findings, estimates based on the second and fifth plausible values reveal that the expected mathematics achievement of students whose parents have at least a college or university education is significantly higher than that of students whose parents have primary education. Furthermore, estimates based on the third plausible value suggest that the expected mathematics achievement of students whose parents have at least a secondary education is significantly higher than that of students whose parents have primary education. As to family environment and related factors, the supplementary analyses indicate that the expected mathematics achievement is significantly lower among students from stepfamilies and students' mathematics achievement increases with number of books at home.

In terms of the student's perceived importance of mathematics and student's educational expectations, estimates based on the four other plausible values show that the expected mathematics achievement is significantly higher among students wanting to do well in mathematics to please their parents and themselves, students wanting a job involving mathematics, and students expecting to attain a college or university education. In terms of school characteristics, the supplementary analyses indicate that the expected mathematics achievement is significantly higher among students from schools located in urban areas but decreases with the difficulty in recruiting mathematics teacher.

Turning to the student's science achievement, estimates based on the four other plausible values reveal that the expected science achievement is significantly higher for male students than for female students. Once gain, for other plausible value specific findings, results pertaining to family human capital show that estimates based on the second suggest that the expected science achievement of students whose parents have at least a secondary education is significantly higher than that of students whose parents have primary education. Estimates based on the fourth and fifth plausible value suggest that the expected science achievement of students whose parents have at a college or university education is significantly higher than that of students whose parents have primary education. With reference to family living arrangement, estimates based on the second and third plausible values indicate that the expected science achievement is significantly lower among students from stepfamilies. Estimates based on the third and fourth plausible values suggest that that there is a negative and significant relationship between family size and science achievement. As is the case with the first plausible values, estimates based on the four other plausible values show that students' science achievement increases with number of books at home.

In terms of the student's perceived importance of science and student's educational expectations, estimates based on the four other plausible values show that the expected science achievement is significantly higher among students wanting to do well in science to please themselves and students expecting to attain a college or university education. For plausible value specific findings, estimates based on the second, fourth and fifth plausible values reveal that the expected science achievement is significantly higher among students wanting to do well in science to please their parents. Furthermore, estimates based on the second and third plausible values reveal that the expected science achievement is significantly higher among students wanting to do well in science in order to get their desired job. Estimates based on the second, fourth, and fifth plausible values also suggest that the expected science achievement is significantly higher among students wanting a job involving science. In terms of school characteristics, the supplementary analyses indicate that indicate that the expected science achievement is significantly higher among students from schools located in urban areas. Additionally, estimates based on the third, fourth and fifth plausible values suggest that the student's science achievement decreases with the difficulty in recruiting science teacher.

Given the above findings, it can be concluded that the hypothesis about Malay's disadvantage was supported for mathematics achievement. The multilevel modeling analyses using the second, third, fourth, and fifth plausible values all showed that Non-Malay students performed significantly better in mathematics achievement than Malay students, even after family and school characteristics as well as student's perceived importance of mathematics were controlled.

Consistent with the first plausible values, the hypothesis about family characteristics as a mediating process was not confirmed for estimates based on the second, third, fourth, and fifth plausible values; that is, controlling for family characteristics (the type of family living arrangement, family size, parent's education, and the number of books and educational objects at home) only slightly reduced the Malay-Non-Malay gaps in mathematics achievement.

Estimates based on the second, third, fourth, and fifth plausible values provide partial support for the cultural perspective: Malay-Non-Malay differentials in mathematics achievement were reduced when measures for shadow education, student's perceived importance of the subject, and student's educational expectations were controlled in Model 4. Estimates based on the second, third, fourth, and fifth plausible values provided partial support for the hypothesis about school context as a mediating process: Malay-Non-Malay differentials in mathematics achievement were further reduced when measures for the school financial, social and human capital were controlled.

In congruence with the first plausible values, the results demonstrate that the structural and cultural perspectives work differently for Malay and Non-Malay students. The hypothesis about the possible interaction effects between ethnicity and family characteristics was supported for both mathematics and science achievement for estimates based on the four other plausible values. Estimates based on the second plausible value, however, differed slightly from that of the first plausible values, namely the positive effect of both the number of educational objects and the number of books at home on mathematics achievement is stronger among Non-Malay students. As is the case with the first plausible values, estimates based on the fourth plausible value reveal that the positive effect of the number of books at home on mathematics achievement is stronger among Non-Malay students. But unlike the first plausible values, estimates based on the third and fifth plausible values indicate that the positive effect of the number of books at home on mathematics achievement is slightly stronger among Malay students. As is the case with the first plausible values, estimates based on the second, fourth, and fifth plausible values revealed that the academic disadvantage of step-parent upbringing on mathematics achievement is greater among Malay students for. However, unlike the first plausible values, estimates based on the third plausible value show that the negative effect of the living in a stepparent family is stronger among Non-Malay students.

Unlike the first plausible values, estimates based on the second plausible value reveal that the positive effect of having a parent with college and university education on science achievement is stronger among Non-Malay students. As is the case with the first plausible values, estimates based on the third plausible values show that the positive effect of the number of books at home on science achievement is slightly stronger among Non-Malay students. Unlike the first plausible values, from the estimates based on the second and fourth plausible values, it is found that the positive effect of the number of books at home on science achievement is slightly stronger among Malay students. The effect of family size on science achievement is stronger for Non-Malay students than for Malay students for estimates based on the second, third, fourth and fifth plausible values. As is the case with the first plausible values, estimates based on the second plausible value revealed that the negative effect of the living in a stepparent family on science achievement is stronger among Non-Malay students. Unlike the first plausible values, estimates based on the third and fourth plausible values seemed to show that the negative effect of the living in a stepparent family on science achievement is stronger among Malay students. It is found from estimates based on the fifth plausible value that the effect of the living in a stepparent family on science achievement is about the same for Malay and Non-Malay students.

The hypothesis about the possible interaction effects between ethnicity and students' perceived importance of the subject is supported for both mathematics and science achievements. Consistent with the first plausible values, estimates based on the second, third, fourth, and fifth plausible values reveal that the effects of wanting to do well in mathematics and science to please their parents or themselves are larger among Non-Malay students. Similarly, the effect of wanting a job involving mathematics is larger among Malay students. As is the case with the first plausible values, the effect of wanting a job involving science is greater among Malay students for estimates based on the second and fifth plausible values. Unlike the first plausible values, the effect of wanting a job involving science is greater among Non-Malay students for estimates based on the third and fourth plausible values. Similarly, the hypothesis about the possible interaction effects between ethnicity and shadow education is not supported for the estimates based on the second third, fourth, and fifth plausible values plausible values. As is the case with the first plausible values, the positive effect of urban school location on both mathematics and science achievements are stronger among Non-Malay student for estimates based on the second, third, fourth, and fifth plausible values.

Table A.1: Determinants of Mathematics and Science Achievement, First to Fifth Plausible Values, TIMSS 1999

Mathematics			
Plausible Values	All	Malay	Non-Malay
First	A, D, I, L, M, N, O, P, Q, R, T, Z, AA	A, D, I, L, M, N, P, Q, R, T, Z, AA	D, I, L, M, N, P, Q, R, Z,AA
Second	A, C, D, I, L, M, P, Q, R, T, Z, AA	A, C, D, E, I, L, M, P, Q, R, T, Z, AA	D, E, I, L, M, P, Q, R, Z, AA
Third	A, B, D, I, L, M, P, Q, R, T, Z, AA	A, D, I, L, M, P, Q, R, T, Z, AA	D, L, M, P, Q, R, Z, AA
Fourth	A, D, I, L, M, N, P, Q, R, T, Z, AA	A, D, I, P, Q, R, T, Z, AA	D, L, M, P, Q, R, Z, AA
Fifth	A, C, D, I, L, M, P, Q, R, T, Z, AA	A, C, D, I, L, M, P, Q, R, T, Z, AA	C, D, L, M, P, Q, R, Z, AA
Science			
Plausible Values	All	Malay	Non-Malay
First	A, B, C, D, F, I, L, M, P, Q, R, T, Z	A, C, D, F, J, O, P, Q, R, T, Z	A, C, D, F, L, M, P, R, Z, AA
Second	A, B, C, D, I, L, M, O, P, R, Z	A, C, D, I, M, O, P, R, Z	A, B, C, D, I, L, M, R, Z, AA
Third	A, D, F, I, M, O, R, T, Z	A, B, C, D, F, I, M, T, Z	A, D, I, M, R, Z, AA
Fourth	A, C, D, F, J, L, M, P, R, T, Z	A, C, D, F, M, T, Z	A, D, F, J, L, M, R, Z, AA
Fifth	A, C, D, L, M, P, R, T, Z	A, C, D, M, P, R, T, Z	A, C, D, L, M, R, Z, AA

Note:
Significant coefficients for
A = Gender
B = Parents with secondary education
C = Parents with college and university education
D = Number of books at home
E = Number of educational objects at home
F = Family Size
G = Mother-only families
H = Father-only families
I = Stepfamilies
J = Non-parent households
K = Extra classes in mathematics / science
L = Wanting to do well in mathematics / science to please parents
M = Wanting to do well in mathematics / science to please self
N = Wanting to do well in mathematics / science to get into the secondary school / university I prefer

O = Wanting to do well in mathematics / science to get the job I want
P = Would like a job that involve mathematics / science
Q = Expect to attain college education
R = Expect to attain university education
S = Index of available school resources for mathematics / science instruction
T = Level of difficulty in recruiting mathematics / science teachers
U = Parents assisting as teacher aides in the classroom
V = Parents volunteer in school programs
W = Parents assisting teachers on trips
X = Index of school behavioral problems
Y = Suburban schools
Z = Urban schools
AA=Percent Malay