

A Comparison of Canada and Hong Kong-China through Hierarchical Linear Models:
The Relations among Students' Self-Beliefs in Math, Learning Environment at School,
and Math Performance

by

Zhimei Gu
B.S., Nanjing Normal University, 2003

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ABSTRACT

The purpose of this study was to examine and compare the relationships among students' self-beliefs in mathematics, learning environment at school, and math achievement, at student and school levels, in Canada and Hong Kong-China. Hierarchical linear modeling was utilized to analyze the data from the Programme for International Student Assessment 2003. It was found that school learning environment has more effect on school math achievement in Hong Kong than in Canada. Canada has stronger relationships between students' self-beliefs in math and their math performance than Hong Kong. School variations of self-efficacy effect and self-concept effect are accountable by school learning environment in Hong Kong, but not in Canada. Recommendations for improving students' math performance and future research are provided.

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CHAPTER 1: INTRODUCTION

Students' Beliefs about Themselves, Learning Environment at School, and Achievement

Educators and researchers realize the important roles of students' beliefs about themselves and learning environment at school in students' academic achievement. The idea is supported by Bandura's triadic reciprocity model of causality: "Human functioning is explained in terms of a model of triadic reciprocity in which behavior, cognitive and other personal factors, and environmental events all operate as interacting determinants of each other" (Bandura, 1986, p.18). The present study adopts students' self-concept and self-efficacy in mathematics as two indicators of students' beliefs about themselves. Teacher support in math, disciplinary climate in mathematics lessons, student-related and teacher-related factors affecting the school climate, and teachers' and students' morale and commitment are indicators of learning environment at school. This study explores how they influence students' math achievement based on the data from the Programme for International Student Assessment (PISA) 2003.

Self-concept refers to "one's collective self-perceptions that are formed through experiences with, and interpretations of, the environment, and that are heavily influenced by reinforcements and evaluations by significant other persons" (Schunk, 2003, p.486). The general correlation between self-concept measures and academic achievement measures is $r = +.30$, which is a positive and moderate relationship. The correlations between achievement and academic self-concept are higher than those between achievement and overall self-concept. The highest correlations with achievement are

obtained with domain-specific self-concepts, such as self-concept in mathematics (Wylie, 1979, as cited in Schunk, 2003). There are many studies supporting the positive relationships between students' self-concept in mathematics and their math achievement. For example, according to the research of Koponen and Lasonen (1994), students who feel confident in math have higher math achievement, while those who are not confident in math tend to have lower achievement.

Self-efficacy means "personal beliefs concerning one's capabilities to organize and implement actions necessary to learn or perform behaviors at designated levels" (Schunk, 2003, p.486). Self-efficacy predicts achievement (Bandura, 1997; Pajares, 1996; Schunk, 1995a). Compared with students with low self-efficacy, students with high self-efficacy have greater eagerness, effort, and persistence for learning, which in turn promotes their academic achievement (Schunk, 2003). Moreover, the formation of self-efficacy also depends on the prior experience and achievement (Bandura, 1997; Hagerty, 1997). As Pietsch, Walker, and Chapman stated (2003), efficacy beliefs have a stronger association with academic performance than self-concept because self-efficacy relates to personal confidence of achieving certain outcomes, rather than personal characteristics regarding general ability. There also is a positive relationship between self-concept and self-efficacy (Marsh, et al., 2004).

According to social cognitive theory, environmental factors can affect many self variables, such as self-concept, self-efficacy, self-evaluation, and self-regulatory processes, through the process of internalization (Schunk, 1999). Furthermore,

environmental and self influences can also affect learning and academic achievement (Schunk, 2003). This is the reason why the learning environment at school is especially important and a focus of this study.

The Purpose and Focus of This Research Study

As discussed, students' beliefs about themselves in mathematics, and the learning environment at school are the correlates influencing students' math achievement. However, few researchers have explored their relations in a hierarchical structure. Osborne (2000) stated that students are living within a hierarchical social structure including family, classroom, grade, school, district, state, country, and so forth. Students, who exist within hierarchies and share the same environment and experiences, tend to be more homogeneous than students randomly sampled from the whole population. Therefore, not only should researchers examine those relationships, but also take account of the impact of hierarchies on students' achievement and those relationships in their studies. From this multilevel perspective, the hierarchy for the present study relates to the organization of the data at the student and school levels. Students' beliefs about themselves can be considered at the student level and in relation to the learning environment at the school level. The purpose of this study is to examine the relationships among students' beliefs about themselves in mathematics, learning environment at school, and math achievement, on student and school levels of a hierarchy, in Canada and Hong Kong-China respectively. It is important to look at two levels of the data and provide reasonable interpretations related to the factors that influence the students' math

achievement.

The contexts of different countries may also affect these relationships. To better understand these relationships, a comparative study could provide valuable perspectives. For example, in accordance with the intra-class correlations for PISA 2003 math results, the proportion of students' achievement variance attributable to schools in Canada (0.20) is less than half of the one in Hong Kong-China (0.49), which means the effects of school characteristics on students' math achievement in Canada are more homogenous than Hong Kong-China. Additionally, from the statistics of the PISA 2003, although the mean performance of Hong Kong-China is statistically significantly higher than Canada, on average students in Hong Kong-China judge their abilities in math much more negatively than in Canada. The judgments students make about themselves depend on the contexts they are in and students' immediate environment is important to develop self-concept and self-efficacy (OECD, 2004).

PISA is based on the international cooperation, which makes it convenient to do comparisons among countries. In this study, the author chooses to investigate the data collected from Canada and Hong Kong-China in the PISA 2003. Canada and Hong Kong-China are two high performing countries with different relationships between student performance and self-beliefs, different intra-class correlations, and different cultures. The author has been studying in Canada for 3 years as an international student with Chinese educational background. Due to the cross-cultural experience, the author realizes that it is both significant and interesting to examine the students' performance in

these two countries through a comparative study. Consequently, the research questions are as follows:

- (1) At the student level, what are the relationships between students' beliefs about themselves in math (math self-concept and self-efficacy) and their math achievement in Canada and Hong Kong-China respectively?
- (2) At the school level, how does the learning environment at school (teacher support, the disciplinary climate in mathematics lessons, student-related and teacher-related factors affecting the school climate, teachers' and students' morale and commitment) affect mean math achievement across schools and moderate the relationships between students' beliefs about themselves in math and their math achievement in Canada and Hong Kong-China separately?
- (3) What are the differences between Canada and Hong Kong-China in those relationships?

Hierarchical linear modeling (HLM) provides researchers with a handy tool to analyze multilevel data and has some advantages over traditional regression. The steps of this study are (1) making a HLM for each of the two countries, focusing on students' beliefs about themselves on the student level, and the learning environment and school climate at the school level; (2) examining differences between the two HLMs for the two countries; (3) making recommendations for improving students' math achievement in the two countries according to the findings of this study.

This research will help to better understand the differences in students'

performance between the two countries by exploring the relationships among students' math achievement, students' beliefs about themselves in mathematics, and school characteristics about the learning environment and school climate. The differences in the two HLMS of Canada and Hong Kong-China may be the reflection of the two various educational systems and cultural values. The results of this study will be useful for governments and schools to make their policy decisions, which in turn, might improve students' academic achievement and the whole educational systems.

CHAPTER 2: REVIEW OF THE LITERATURE

What is Self-concept?

Self-concept refers to “one’s collective self-perceptions that are formed through experiences with, and interpretations of, the environment, and that are heavily influenced by reinforcements and evaluations by significant other persons” (Schunk, 2003, p.486). According to the internal/external frame of reference model, students form their self-concept in relation to their positions relative to other students (external) and their relative performance on different school subjects (internal) (Marsh & Shavelson, 1985; Marsh, 1986, 1988a; Marsh, Byrne & Shavelson, 1988).

Self-concept is an important factor that contributes to educational outcomes (Marsh, 1993). Marsh and Shavelson (1985) argued that self-concept is a multi-dimensional construct composed of verbal, mathematics, general, and academic self-concept. The research findings support the domain-specificity and the multidimensional nature of self-concept (Byrne, 1984, 1986; Byrne & Gavin, 1996; Byrne & Shavelson, 1986; Marsh, 1993; Marsh, Barnes, & Hocevar, 1985; Marsh, Byrne & Shavelson, 1988; Marsh & O’Neill, 1984; Marsh & Yeung, 1996, 1997a, 1997b).

Relationships between Self-concept and Achievement in Mathematics

Research has been conducted exploring the relationships between self-concept and academic achievement. The general correlation between self-concept measures and academic achievement measures is $r = +.30$, a positive and moderate relationship.

Academic achievement is more highly correlated with academic self-concept than overall

self-concept. The highest correlations with achievement are obtained with domain-specific self-concepts, such as mathematics self-concept (Wylie, 1979, as cited in Schunk, 2003).

Longitudinal data collected in 3 high-school subjects (mathematics, science, and English) in each of 3 years (N=603) showed that academic achievement had substantial effects on subsequent academic self-concept after controlling prior academic self-concept and that academic self-concept also had substantial effects on subsequent academic achievement after conditioning prior academic achievement (Marsh & Yeung, 1997a). Furthermore, Marsh (1990 a) found that school average achievement tends to have a negative association with students' self-concept.

The positive relationships between students' mathematics self-concept and mathematics achievement are supported by many studies. Yeung and Lee (1998) administered a Chinese version of Marsh's (1992b, 1992d) Self Description Questionnaire (SDQII) to high school students in China at two time points (T1 and T2) six months apart. In total 511 students participated and the responses of 487 students were used. The reliability estimates for the math self-concept were good (alphas = .91 for T1 and T2) and validity was promising. The results indicated that math self-concept was positively correlated with math exam scores ($r = .49$ for T1 and $r = .32$ for T2). One limitation of this study is that the participants had generally high math self-concept (mean = 4.42 for T1 and 4.47 for T2, in a 6-point scale) and math exam scores (mean = 80.13 and 84.65 for T1 and T2, respectively). Further investigation may be required for the

generalization of the findings. Marsh (1988) also found that mathematics self-concept is significantly positively associated with mathematics skills, and negatively related to school average achievement.

There are very few cross-cultural studies conducted on children's self-perceptions about themselves as related to school achievement. It was found that Chinese children tended to downgrade their abilities and self-worth in relation to American children (Stigler, Smith, & Mao, 1985), although students in Asia outperformed North American children in math (Stigler, Lee, Lucker, & Stevenson, 1982),

Kwok and Lai (1993) investigated the differences in self-perceptions of competence between elementary school children in Canada and Hong-Kong China. The Self-Perception Profile for Children (SPPC) (Harter, 1985) was administered to 125 fourth-grade Canadian children who were randomly selected from schools in a large urban school district, including 62 girls and 63 boys. The SPPC was translated into Chinese and given to 128 children, including 62 girls and 66 boys, in Chinese speaking schools in Hong Kong. The children took a math achievement test that had been used with 1st and 5th grade children in Japan, Taiwan, and the U.S. (Stigler et al., 1982). The internal consistency reliabilities ranged from .71 to .89 for SPPC and from .93 to .95 for the math achievement test. The findings indicated that (1) Hong Kong Chinese students outperformed the Canadian students on the math test ($F(1, 236)=23.69, p<.001$); (2) there were significant and positive correlations between perceived scholastic competence and performance on the math test for Canadian students ($r=.347, p<.001$) and Hong

Kong Chinese students ($r = .170, p < .05$); and (3) Chinese children judged their competence in different domains more negatively as compared with Canadian children, such as in scholastic competence ($F(1, 224) = 7.35, p < .01$) and global self-worth ($F(1, 224) = 12.89, p < .001$). What is noteworthy is that the SPPC assesses the multi-dimensional self-perceptions about scholastic competence, social acceptance, athletic competence, physical appearance, behavioral conduct, as well as general self-perceptions of competence, but not specific self-perceptions in math. Higher correlations are expected between self-perceptions in math and math performance. Hau, et al. (2000) also found that mathematics achievement had positive effects on mathematics self-concept with a representative sample ($N = 9,482$) of Hong Kong high school students.

How to Measure Mathematics Self-concept?

Because of the multidimensionality of self-concept (Marsh & Shavelson, 1985), it is important to measure domain-specific self-concept (Yeung & Lee, 1998). A series of instruments was designed for measuring mathematics self-concepts.

Some of the researchers conducted interviews to measure mathematics self-concept. For example, Signer, Beasley and Bauer (1997) asked the secondary students in the interview to answer the following questions: (1) how would you characterize your math grades? (2) What do you think is the reason for your math grades? (3) How do you feel about your math grades? Please explain your answer. (4) Describe yourself as a math student. (5) If given the opportunity, would you take more advanced math courses? Please explain your answer. The advantage of interviews is that researchers can obtain more

underlying information and understand the reasons for the answers.

Most researchers chose questionnaires to assess students' mathematics self-concept. Verna and Spina (2002) used the Inventory of Parental Influence (IPI) (Campbell, 1994) Part III, Self Aptitude Attribute Scale (SAAS) to measure math self-concept. The Alpha reliability coefficient for mathematics self-concept was .86. This instrument could be used with cross-cultural samples.

The Self-Description Questionnaire (SDQ; Marsh 1987, 1988b) was commonly used to assess self-concept. The SDQ was based on the hierarchical, multifaceted model of self-concept (Shavelson, Hubner, & Stanton, 1976). Marsh (1987) demonstrated the rationale for the SDQ and the evidence supporting its reliability and validity. The Self-Description Questionnaires (SDQs) I, II, and III (Marsh, 1992a, 1992b, 1992c) are appropriate for use with preadolescents (grades 2-6), early adolescents (grade 7-11), and late adolescents (grade 11-college), respectively. The SDQ-I uses a 5-point Likert scale, ranging from "false" to "true", to indicate the extent to which respondents agree or disagree with the statements. The SDQ-II applies a 6-point Likert scaling format (false-true). The SDQ-III is based on an 8-point Likert scaling format (definitely false-definitely true). Findings from construct validity studies provide ample evidence supporting all three SDQ instruments (Byrne, 1996; Marsh, 1992a, 1992b, 1992c).

Since the target population of the present study is 15-year old students, the SDQ-II matches the age of the PISA population. The SDQ- II measures eleven areas of self-concept, including three academic domains (English, Math, and General Academic),

seven nonacademic domains, and a general self-concept (Marsh, 1990b). There are 10 items to measure mathematics self-concept by using a 6-point scale (1=false to 6=true).

What is Self-efficacy?

Bandura (1986) defined self-efficacy as “people’s judgments of their capabilities to organize and execute courses of action required to attain designated types of performance”(p.391). Schunk (2003) referred self-efficacy to “personal beliefs concerning one’s capabilities to organize and implement actions necessary to learn or perform behaviors at designated levels” (p.486). Self-efficacy is domain-specific and distinct from global self-concept (Bandura, 1986, as cited in Lent, Lopez, & Bieschke, 1993).

Self-efficacy has its basis in Bandura’s (1986) social cognitive theory. Self-efficacy beliefs are dependent on four sources: (1) Successful completion of a target behavior; (2) Observation of another person’s completion of a target behavior, particularly when he/she believes the model is similar to him/her; (3) Verbal persuasion; (4) Physiological state. Once information is conveyed, it will be weighed and integrated into a self-efficacy judgment (Bandura, 1997; Hagerty, 1997). Efficacy perceptions are also “shaped by interpersonal experiences, such as support and encouragement for mastering particular activities, and differential exposure to efficacious role models” (Bandura, 1986, as cited in Lent, Lopez, & Bieschke, 1993, p. 233).

People with strong self-efficacy believe that they can execute the required behavior. They will choose to face a complex and difficult situation instead of avoiding it, due to

their expectation of success (Hagerty, 1997). They may also use a wide variety of cognitive strategies as well as cognitive engagement to overcome the difficulties (Pintrich & DeGroot, 1990). Bandura (1993) stated that perceived self-efficacy affects human behavior not only through cognitive processes but also through motivational processes. "Self-efficacy beliefs contribute to motivation in several ways: They determine the goals people set for themselves, how much effort they expend, how long they persevere in the face of difficulties, and their resilience to failures" (p.131). Bandura (1986) also stated that "the stronger the perceived self-efficacy, the more likely are persons to select challenging tasks, the longer they persist at them, and the more likely they are to perform them successfully" (p.397).

Relationships between Self-efficacy and Achievement in Mathematics

Self-efficacy predicts achievement (Bandura, 1997; Pajares, 1996). Compared with students with low self-efficacy, students with high self-efficacy have greater eagerness, effort, and persistence for learning, which in turn help them to do well on tasks and promote their academic achievement (Hembree, 1988; Schunk, 2003). Pajares and Miller (1994) found a significant direct path from self-efficacy to academic achievement ($r = .35$, $p < .05$). Moreover, the formation of self-efficacy also depends on the prior experience and achievement (Bandura, 1997; Hagerty, 1997). The present study specifically focuses on the domain of mathematics self-efficacy.

Research has generally confirmed a positive relationship between mathematics self-efficacy and student performance, however, different sizes of the correlation were

reported, depending on how the self-efficacy was measured (Multon, Brown, & Lent, 1991). Hagerty (1997) investigated the impact of the efficacy process on students in four Sacramento (California) City Unified School District pilot schools over a four-year period. These four pilot schools took part in the program for enhancing students' self-efficacy. Another four schools with similar socioeconomic status (SES) rankings and Comprehensive Tests of Basic Skills (CTBS) results were identified as comparison schools. Grade 3 students in 1992-93 completed the School Attitude Measure (American College Testing) (SAM) and the CTBS in reading, language, and math in each of the three successive years. The findings showed that over the period of the study, students' performance significantly rose within the four Efficacy schools and within the four non-efficacy schools selected for comparison. However, there was significantly more improvement in math for the pilot Efficacy schools than the comparison schools ($p < 0.05$). No statistically significant relationships were found between SAM results and math scores, although the correlations and scatterplots were linear and weakly positive. A possible reason for this is that SAM measures the broad construct of self-efficacy in the setting of school and classroom, rather than the specific self-efficacy in math.

Lent, Lopez, and Bieschke (1993) explored prior achievement, self-efficacy, outcome expectations and interests in predicting students' choice of, and performance in mathematics-related college courses. 166 introductory psychology students (59 males, 107 females) participated in this study. A self-report for measuring mathematics self-efficacy, the revised version of Betz and Hackett's (1983) Mathematics

Self-Efficacy—College Courses Scale, was administered to the students with high internal consistency ($\alpha = .94$). Their mathematics American College Test (ACT) scores were obtained from university records. The findings showed that mathematics self-efficacy was a useful predictor of mathematics grades. The mathematics self-efficacy was positively associated with mathematics ACT scores ($r = .51, p < .01$) as well as with grades in mathematics-related courses ($r = .39, p < .01$).

Malpass and colleagues (1996) investigated the effects of self-regulated learning, self-efficacy, learning goal orientation, and worry on high-stakes mathematics achievement—the Math Scholastic Aptitude Test (M-SAT) and the Advanced Placement exam in calculus (APX). The sample consisted of 144 mathematically gifted high school students (78 boys and 66 girls in Grades 10-12). The Self-Regulation Questionnaire designed by O'Neil et al. (1992) was used to measure the four latent variables: self-regulated learning, self-efficacy, learning goal orientation, and worry. The results of the study showed that self-efficacy was strongly and positively related to mathematics achievement ($r = .52$ for SAT and $.56$ for APX). Moreover, a significant direct path from self-efficacy to mathematics performance was found ($\beta = .55, p < .05$). One caution is that the participants were mathematically gifted, consisting of 60 percent Asian-Americans and 35 percent Whites. It might be a problem if generalizing the findings to students who are not good at math.

Stevens et al. (2004) found significantly positive relationships between mathematics self-efficacy and mathematics performance for Caucasian ($r = .46, p < .01$) and Hispanic

students ($r = .41, p < .01$). With a group of high school students as the sample, Pajares and Kranzler (1995) found a significant direct path from self-efficacy to mathematics performance ($r = .35, p < .05$).

Besides the research mentioned above, many other studies focus on mathematics self-efficacy as well. Findings indicate that mathematics self-efficacy beliefs are positively related to mathematics performance (Cooper & Robinson, 1991, Hackett & Betz, 1989; Siegel, Galassi, & Ware, 1985) and mathematics self-efficacy predicts math grades (Lent et al., 1993).

How to Measure Mathematics Self-efficacy?

Researchers used various types of self-efficacy measures in their studies. Unlike academic self-concept research that relies on more general, survey-type measurement procedures, academic self-efficacy research often obtains students' confidence ratings about specific tasks or problems (Bong, 1998).

Betz and Hackett's (1983) Mathematics Self-Efficacy—College Courses Scale asked participants to report their confidence in being able to complete 15 mathematics-related college courses with a grade of B or better, on a 10-point rating scale. A total mathematics self-efficacy score for each participant was obtained through summing individual course ratings and dividing by 15. Higher scores indicated more positive self-efficacy. The internal consistency coefficient was acceptable ($\alpha = .93$) (Betz & Hackett, 1983).

The Patterns of Adaptive Learning Survey (PALS; Midgley et al., 1997) has been used to measure student goal orientations, perceived classroom goal structures, and

mathematics self-efficacy (Gutman, 2006). Midgley et al. (1998) reported evidence of the validity of these scales. All items are scored on a 5-point scale ranging from 1 (not at all true of me) to 5 (very true). There are 5 items for mathematics self-efficacy, such as “I am certain I can master the skills taught in math this year.” and “I can do even the hardest work in my math class if I try.”

In the student questionnaires of the Third International Math and Science Study (TIMSS) developed by the International Association for the Evaluation of Educational Achievement (IEA), there are several items for measuring students’ mathematics self-efficacy. For example, an item asked students whether they agree with the statements (on a 4-point scale): (a) I like mathematics; (b) I enjoy learning mathematics; (c) Math is an easy subject; (d) I would like a job involving mathematics (Rodriguez, 2004).

Pajares and Graham (1999) created a task-specific mathematics self-efficacy instrument for end of year eighth-grade students. There are 20 grade-appropriate algebraic problems on an 8-point Likert-type scale ranging from “not confident at all” to “completely confident”. Students were asked to report their level of confidence in correctly solving the problems. Pajares and Graham (1999) provided the evidence of validity and reported consistent estimates of reliability across samples (Cronbach’s alpha coefficients at or near .94).

Randhawa, Beamer, and Lundberg (1993) used the Mathematics Self-Efficacy Scale (MSES) to assess students’ self-efficacy in performing everyday mathematics tasks (daily subscale), solving mathematics academic problems (problems subscale), and completing

mathematics-related high school courses (courses subscale). Students reported their confidence level on a 10-point scale ranging from “no confidence at all” to “complete confidence”. The alpha reliabilities of the three scales were .88, .89, and .92, respectively.

In the Mathematics Confidence Scale (MCS) (Dowling, 1978), there are 18 problems that represent three components of mathematics (arithmetic, algebra, and geometry), three levels of cognitive demand (computation, comprehension, and application), and two problem contexts (real and abstract). One example of the items is: There are three numbers. The second is twice the first and the first is one-third of the other number. Their sum is 48. Find the largest number. Langenfeld and Pajares (1992) reported a Cronbach’s alpha coefficient of .91 in a factor analytic study with 520 undergraduates. Pajares and Kranzler (1995) obtained a coefficient of .92 with a high school sample after they modified the 5-point Likert scale of MCS to 6 points, and the item-total score correlations ranged from .30 to .74.

Because efficacy judgments are task-specific, most instruments mentioned above are measuring students’ self-judgments related to various tasks. As Bandura (1986) cautioned, “A self-efficacy measure must assess the same skills called for in the performance task with which it is to be compared, and it must be administered as closely as possible in time to that performance” (Pajares & Kranzler, 1995, p.4). In order to promote prediction, measures of self-efficacy could be tailored to the task being assessed and the domain of functioning being analyzed (Pajares & Miller, 1995, as cited in Pajares & Kranzler, 1995).

Learning Environment at School

According to the social cognitive theory, environmental factors can affect many self variables, such as self-efficacy, self-evaluation, and self-regulatory processes, through the process of internalization (Schunk, 1999). Furthermore, environmental and self influences can also impact learning and academic achievement (Schunk, 2003). Consequently, it is important to incorporate environmental variables with self variables and academic performance (Lent, Lopez, & Bieschke, 1993).

As demonstrated by Bandura's Triadic Reciprocity Model of Causality, "Human functioning is explained in terms of a model of triadic reciprocity in which behavior, cognitive and other personal factors, and environmental events all operate as interacting determinants of each other" (Bandura, 1986, p.18). The model is shown as below:

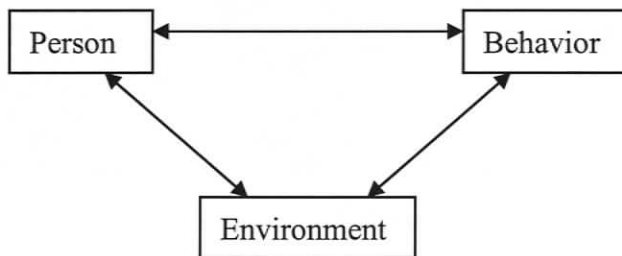


Figure 1. Triadic reciprocity model of causality. *Source: Social Foundations of Thought and Action* by Bandura (1986).

Furthermore, Osborne (2000) stated that students are living within a hierarchical social structure including family, classroom, grade, school, district, state, country, and so forth. Students, who exist within hierarchies and share the same environment and experiences, tend to be more homogeneous with each other than students randomly

sampled from the whole population. Therefore, not only should the researchers examine the relationships between academic achievement and self variables, but also consider the impact of environment on students' performance and those relationships. However, this important point, to a large extent, has been ignored in the past studies.

In accordance with what was discussed previously, it is significant to explore the relationships between mathematics self-concept/mathematics self-efficacy and students' math achievement, combining the factors of learning environment at school. Few studies were conducted on how these relationships changed under different learning environment. The present study examines the environmental data from both students and principals in the Programme for International Student Assessment (PISA) 2003. Students reported their perceptions of the teacher support in mathematics and disciplinary climate in mathematics lessons. Principals provided their views on student-related and teacher-related factors affecting the school climate, and teachers' and students' morale and commitment. One of the research questions in the present study is: how does the learning environment at school affect mean math achievement across schools and moderate the relationships between students' beliefs about themselves in math and their math achievement in Canada and Hong Kong-China separately?

The PISA 2003

Introduction

The OECD's Programme for International Student Assessment (PISA) is an international comparative assessment of student achievement. The primary aim of PISA

is to determine the extent to which young people, at age 15, have acquired the knowledge and skills in reading, mathematics, and science that they will need in adult life. PISA is an on-going and long-term programme that conducts surveys every three years to monitor trends in students' knowledge and skills in various countries. It allows comparisons between and within countries, and comparisons of the change over time. One of the three domains (reading, mathematics, and science) is tested in detail on each occasion. The PISA 2003 focuses on mathematics assessed in relation to the mathematical content, the process of mathematics, and the situations in which mathematics is used (OECD, 2003, 2004).

The most fundamental feature of PISA is that the knowledge and skills tested are not directly linked to the curriculum but the essentiality for the future life. That means, PISA does not exclude the curriculum-based knowledge, but it concentrates more on the abilities that allow the knowledge and skills to be applied in real-life challenges. Furthermore, not only does PISA assess the degree of preparedness of young people for adult life, but also the effectiveness of educational systems. PISA indicates the directions for improving educational outcomes for the governments because of its policy orientation (OECD, 2003, 2004).

The PISA 2003 employs paper-and-pencil format and includes various types of questions, such as multiple choice, short-response, and open-constructed response items. Because the PISA 2003 focuses on mathematics, three-and-a-half hours of testing time are devoted to the assessment of mathematics, and one hour is for each of the reading,

science, and problem solving assessments. The results of the PISA 2003 are reported on a scale with an average score of 500 and a standard deviation of 100 for all three domains (mathematics, reading, science), plus a new reporting scale for problem solving as a cross-curricular competency (OECD, 2003, 2004).

Questionnaires in PISA

In order to gather information about student and school characteristics, PISA asks students and their school principals to answer background questionnaires that are around 20 to 30 minutes in length. The information focus in the student questionnaire is centred on the backgrounds of students and their families, their learning habits, their perceptions of the learning environment, educational careers, as well as their engagement and motivation. School principals answer a questionnaire about their schools' demographic characteristics, students and teachers in their schools, the quality of the learning environment at school, school resources, and some of the pedagogical practices and administrative structures. The data collected from the questionnaires are valuable for understanding what factors may promote success in education (OECD, 2003, 2004).

The information about students' beliefs about themselves in mathematics and the learning environment at school, which are the interest of this study, was collected through the student and school questionnaires. The PISA 2003 Student Questionnaire generated indices for measuring math self-concept and math self-efficacy that are two indicators of students' beliefs about themselves in mathematics. Teacher support in math, disciplinary climate in mathematics lessons, student-related and teacher-related factors affecting the

school climate, and teachers' and students' morale and commitment are indicators of the learning environment at school. Teacher support in math and the disciplinary climate in mathematics lessons were based on students' responses in the PISA 2003 Student Questionnaire, while school principals reported their views on student-related and teacher-related factors affecting the school climate, and teachers' and students' morale and commitment in the PISA 2003 School Questionnaire. The detailed items are shown in the Appendix A. The answers on the items were combined to a scaled composite index for each indicator, with values centered at 0 and ranging from -3 to +3.

Collaboration in PISA

PISA presents international collaboration among the OECD member governments. "The assessments are developed co-operatively, agreed by participating countries, and implemented by national organizations" (OECD, 2003, p.19). Experts from participating countries work together to ensure that the instruments are internationally valid and to take into account the cultures, languages, and education in OECD member countries. The participating countries implement PISA at the national level through National Project Managers (NPM) following the agreed administration procedures. Because of the stringent quality assurance mechanisms applied in translation, sampling, and data collection, the results of PISA have a high degree of validity and reliability. Consequently, PISA can improve understanding of the educational outcomes in various countries in the world and explain the differences in performance among or within countries (OECD, 2003, 2004).

The PISA 2003 was conducted in 41 countries around the world, including 30 OECD member countries. Over a quarter of a million students, representing about 23 million 15-year-olds in the schools of the 41 countries, participated in the PISA 2003. These sufficiently large scientific samples selected by rigorous standards allow valid comparisons between or within the countries. Because of PISA's policy orientation, policy makers usually apply PISA findings to: (1) measure the literacy skills of students and compare with other countries; (2) establish benchmarks for improving educational outcomes; (3) understand relative strengths and weaknesses of the different educational systems (OECD, 2004).

Hierarchical Linear Model (HLM)

What is HLM?

Osborne (2000) stated that students are living within a hierarchical social structure including family, classroom, grade, school, district, state, country, and so forth. Students, who exist within hierarchies and share the same environment and experiences, tend to be more homogeneous with each other than students randomly sampled from the whole population. HLM is an important method in educational research where data are naturally nested. For instance, in a two-level model (such as student and school levels), at the student level, the model estimates how student-level predictors are related to the outcome variable. At the school level, the model estimates how school-level variables predict the average of the outcome variable across schools, and whether school-level predictors moderate the regression slopes between student-level predictors and the outcome variable

(Schreiber & Griffin, 2004).

Null Model

Null model, also named the base model, is the most basic model in HLM. It is equivalent to a one-way ANOVA with random effects. Estimating the null model is important as a preliminary step in a hierarchical data analysis, because it provides information about the variability of the outcome variable at each of the two levels (Bryk & Raudenbush, 1992). The equations are:

$$\text{Student level: } Y_{ij} = \beta_{0j} + r_{ij}$$

$$\text{School level: } \beta_{0j} = \gamma_{00} + u_{0j}$$

where the subscript i indicates 1, 2, 3, ..., n students and j indicates 1, 2, 3, ..., j schools.

At the student level, Y_{ij} is the outcome variable (math achievement here) for student i in school j . β_{0j} is the intercept and can be considered the conditional mean of the outcome variable for school j . r_{ij} is the deviation from this mean for Student i in School j and can be considered as student-level error. At the school level, γ_{00} is the overall, across-school mean of the outcome variable Y_{ij} . u_{0j} is the error term from overall mean γ_{00} for the mean in School j . The variances of the error terms u_{0j} and r_{ij} are notated as τ_{00} and σ^2 , respectively. This model enables researchers to test whether the mean of the outcome variable significantly varies across schools and how much the variance of the outcome variable can be accounted by the school level through calculating the intra-class correlation (ρ): $\tau_{00}/(\tau_{00} + \sigma^2)$ (Bryk & Raudenbush, 1992; Schreiber & Griffin, 2004).

Intercept and Slope as Outcomes Model

The model including both student-level and school-level predictors is commonly used in research. The equations are:

$$\text{Student level: } Y_{ij} = \beta_{0j} + \beta_{1j}X_1 + \beta_{2j}X_2 + \dots + \beta_{nj}X_n + r_{ij}$$

$$\text{School level: } \beta_{0j} = \gamma_{00} + \gamma_{01}W_1 + \gamma_{02}W_2 + \dots + \gamma_{0k}W_k + u_{0j}$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11}W_1 + \gamma_{12}W_2 + \dots + \gamma_{1k}W_k + u_{1j}$$

$$\beta_{2j} = \gamma_{20} + \gamma_{21}W_1 + \gamma_{22}W_2 + \dots + \gamma_{2k}W_k + u_{2j}$$

.....

$$\beta_{nj} = \gamma_{n0} + \gamma_{n1}W_1 + \gamma_{n2}W_2 + \dots + \gamma_{nk}W_k + u_{nj}$$

At the student level, $\beta_{1j}, \beta_{2j}, \dots, \beta_{nj}$ are the slopes for the student-level predictors X_1, X_2, \dots, X_n . r_{ij} indicates the student-level error. $W_1, W_2, \dots,$ and W_k are the variables at the school level. $\gamma_{10}, \gamma_{20}, \dots, \gamma_{n0}$ signify the average slopes of X_1, X_2, \dots, X_n for j schools. $\gamma_{01}, \gamma_{02}, \dots, \gamma_{0k}$ are coefficients estimating the association between W_1, W_2, \dots, W_k and the school mean β_{0j} . $\gamma_{11}, \gamma_{12}, \dots, \gamma_{1k}, \dots, \gamma_{n1}, \gamma_{n2}, \gamma_{nk}$ are coefficients estimating the association between W_1, W_2, \dots, W_k and the slopes $\beta_{1j}, \beta_{2j}, \dots, \beta_{nj}$. u_{0j}, \dots, u_{nj} are all school-level error terms after conditioning $W_1, W_2, \dots,$ and W_k . The variances of $u_{0j}, u_{1j}, \dots, u_{nj}$ are denoted by $\tau_{00}, \tau_{11}, \dots,$ and τ_{nn} . Whether the variance of u_{0j} (τ_{00}) is significant or not indicates whether the mean of the outcome variable varies significantly across schools after controlling $W_1, W_2, \dots,$ and W_k on the school level. Significant $\tau_{11}, \tau_{22}, \dots, \tau_{nn}$ indicate that the relationships between the outcome variable and X_1, X_2, \dots, X_n are significantly different from school to school even after

conditioning $W_1, W_2, \dots,$ and W_k . Other symbols are interpreted in the same way as in the null model discussed previously. (Bryk & Raudenbush, 1992; Schreiber & Griffin, 2004).

Summary

The literature generally confirms the positive relationships between students' math self-concept/math self-efficacy and their mathematics achievement although the strength of the relationships may differ, depending on how the variables are measured. However, the past research to a large extent ignored the impact of environment on the relationships between students' math self-concept/math self-efficacy and their mathematics achievement. Moreover, few cross-cultural studies were conducted on children's perceptions about themselves as associated with school achievement. The present study tries to promote the understanding about the relationships between math self-concept/math self-efficacy and math achievement under different learning environments at school in Canada and Hong-Kong China through using HLM. The data are from the OECD's PISA 2003. The review of the instruments used for measuring math self-concept and self-efficacy is for making some recommendations about how to measure them for the future PISA in the later chapters.

CHAPTER 3: METHOD

Participants

The target population in PISA consists of the students who are still at school and aged between 15 years 3 months and 16 years 2 months at the time of assessment, regardless of the grade, institutions, and full-time or part-time education. This allows the performance of students at the same age with different educational experience to be compared across countries and over time.

National or international surveys usually collect and deal with data from a representative sample rather than the whole population. In PISA, a two-stage sampling procedure is used: first, a sample of schools is selected from a list of schools containing the student population of interest; second, a simple random sample of students is drawn within the selected schools. The specific sample design and the sufficient sample size for each country ensure the valid comparisons (generally a minimum sample size of 4,500 students selected from a minimum of 150 schools). The selection of samples is monitored internationally and rigorous standards are applied to make sure an adequate participation rate (a response rate of more than 85% for initially selected schools and a student response rate of more than 80% in each sample school) (OECD, 2004, 2005a). In total 27,953 students from 1,087 schools in Canada and 4,478 students from 145 schools in Hong Kong-China participated in the PISA 2003 respectively. These students in the two countries are the sample of the present study.

Instruments

All the data in this study were collected by the OECD in the PISA 2003. For international assessments, translation errors could be a cause of items functioning poorly. PISA implements very strict and effective procedures for translation equivalence, including providing two parallel source versions of the instruments in English and French and recommending each country to use double translation and reconciliation from the two different languages, appending translation notes to help with possible problems, developing detailed translation and adaptation guidelines, training key staff from each national team, and appointing and training a team of independent translators (international verifiers) to verify the national versions against the source versions (OECD, 2005b). The reliability estimates are good for both Canada ($\alpha = 0.90, 0.86, 0.86, 0.84, 0.83, 0.82, 0.87,$ and 0.83 for math self-concept, math self-efficacy, teacher support, disciplinary climate, student behaviors, teacher behaviors, student morale, and teacher morale, respectively) and Hong Kong-China ($\alpha = 0.86, 0.87, 0.84, 0.88, 0.95, 0.92, 0.85,$ and 0.80 for math self-concept, math self-efficacy, teacher support, disciplinary climate, student behaviors, teacher behaviors, student morale, and teacher morale, respectively).

The variables used in this study are described below. The items for measuring the variables are shown in the Appendix A.

Mathematics Self-Concept

Mathematics Self-Concept was measured as a scaled index with values centered at 0 and ranging from -3 to $+3$. This index was constructed through one-parameter item

response theory (IRT) scaling (OECD, 2004). Positive values indicate positive self-concept in mathematics. Students were asked to answer the extent to which they agreed with the following statements: I am just not good at math; I get good marks in mathematics; I learn mathematics quickly; I have always believed that mathematics is one of my best subjects; in my mathematics classes; I understand even the most difficult work.

Mathematics Self-Efficacy

The data on students' mathematics self-efficacy were gathered through the PISA 2003 Student Questionnaire. Mathematics Self-Efficacy is a scaled index with values centered at 0 and ranging from -3 to +3. Positive scores represent high levels of self-efficacy in mathematics. Students reported their confidence levels in relation to the 8 items that were inverted for IRT scaling: Using a train timetable to work out how long it would take to get from one place to another; calculating how much cheaper a TV would be after a 30% discount; calculating how many square meters of tiles you need to cover a floor; understanding graphs presented in newspapers; solving an equation like $3x+5=17$; finding the actual distance between two places on a map with a 1:10,000 scale; solving an equation like $2(x+3)=(x+3)(x-3)$; calculating the petrol consumption rate of a car (OECD, 2004).

Students' Perceptions of Teacher Support in Mathematics

Teacher Support in Mathematics was measured through the PISA 2003 Student Questionnaire. Teacher Support is a scaled index with values centered at 0 and ranging

from -3 to $+3$. The scaling of this index was done by the use of IRT and positive scores on this index indicate students' perceptions of higher levels of teacher support (OECD, 2004). There are 5 items assessing Teacher Support in the questionnaire: The teacher shows an interest in every student's learning; the teacher gives extra help when students need it; the teacher helps students with their learning; the teacher continues teaching until the students understand; the teacher gives students an opportunity to express opinions.

Students' Perceptions of Disciplinary Climate in Mathematics Lessons

Disciplinary Climate, a scaled index centered at 0 and ranging from -3 to $+3$, was measured through the PISA 2003 Student Questionnaire. This index was constructed through IRT scaling. Positive scores indicate students' perceptions of a positive disciplinary climate (OECD, 2004). There are 5 statements used to assess Disciplinary Climate in the questionnaire: Students don't listen to what the teacher says; there is noise and disorder; the teacher has to wait a long time for students to quieten down; student cannot work well; students don't start working for a long time after the lesson begins.

Principals' Perceptions of the Student-Related Factors Affecting the School Climate

Through the PISA 2003 School Questionnaire, principals were asked questions about their perceptions of student-related factors affecting the school climate, including students' absenteeism, disruption of classes by students, students skipping classes, students lacking respect for teachers, students' use of alcohol or illegal drugs, and students intimidating or bullying others. The answers from principals were combined to a composite index of student-related factors affecting the school climate through IRT

scaling. On this school-level index, values above zero reflect positive disciplinary climate in school principals' opinions; values below zero reflect that the school climate is less than the OECD average (OECD, 2004).

Principals' Perceptions of the Teacher-Related Factors Affecting the School Climate

Principals reported their perceptions of teacher-related factors affecting the school climate in the PISA 2003 School Questionnaire, including teachers' low expectations of students, poor student-teacher relations, absenteeism among teachers, staffs' resistance to change, teachers not meeting individual students' need, and students not being encouraged to achieve their full potential. The responses from principals were combined to a composite index of teacher-related factors affecting the school climate through IRT scaling. Positive values indicate that in principals' opinions, teacher-related factors affecting the school climate hinder learning to a lesser extent, while negative values reflect that teachers' behaviors hinder learning to a greater extent, compared to the OECD average (OECD, 2004).

Principals' Views on Teachers' Morale and Commitment

Principals were asked to respond how strongly they agreed or disagreed with the four statements concerning the teachers in their schools in the PISA 2003 School Questionnaire. An index of principals' perceptions of teachers' morale and commitment was created through IRT scaling, with an average of zero and a standard deviation of one. Higher index values indicate greater perceived morale and commitment. The four statements are: The morale of teachers in this school is high; teachers work with

enthusiasm; teachers take pride in this school; teachers value academic achievement.

Principals' Views on Students' Morale and Commitment

Based on principals' responses in the PISA 2003 School Questionnaire, an index of principals' perceptions of students' morale and commitment was created with an average of zero and a standard deviation of one through IRT scaling. Higher index values indicate greater perceived morale and commitment. The items used to form this index include: Students enjoy being in school; students work with enthusiasm; students take pride in this school; students value academic achievement; students are co-operative and respectful; students value the education they can receive in this school; students do their best to learn as much as possible (OECD, 2004).

Mathematics Achievement

The PISA 2003 concentrates on mathematical literacy. This study uses the scores on the PISA 2003 Mathematics Assessment as an indicator of students' mathematics achievement. The test scores were scaled by one-parameter IRT to have a mean of 500 and a standard deviation of 100 for all the OECD countries.

In the PISA 2003 datasets, there are five plausible values (PV1math—PV5math) of math scores for each student. Plausible values can be defined as random values for each student from an estimated ability distribution of students with similar item response patterns and backgrounds (the posterior distribution). Plausible values are a representation of the range of abilities that a student might have, and they can provide good country-level estimates of parameters of student population (OECD, 2005a). The

final student weights are also used in this study. The role of the final student weights is to weight students differentially so that biases due to the sample design can be eliminated or reduced (Willms & Smith, 2005).

The Datasets

The data come from the OECD's PISA 2003 database, including some basic demographic information, students' beliefs about themselves in math, the learning environment at school, and their math scores in Canada and Hong-Kong China. Using these data and conducting research on these data in the present study was approved by the OECD and the University of Victoria Human Research Ethics Board.

Data Analysis

The software programs used in this study were SPSS 13.0 and HLM 6.0. Because there are student-level and school-level data, two-level HLMs are conducted based on the data from Canada and Hong Kong-China.

For each of the two countries, the student-level data focus on students' beliefs about themselves in mathematics and their math scores. Two variables were adopted as the indicators of the students' beliefs about themselves in mathematics: students' beliefs in their own academic ability in mathematics (math self-concept) and students' confidence in overcoming difficulties in mathematics (math self-efficacy).

The school-level data concentrate on the learning environment and school climate. There are two variables based on students' views: (1) students' perceptions of individual support from their teachers, and (2) students' views on the disciplinary climate in their

mathematics lessons. In addition, principals' opinions are also involved: (1) principals' perceptions of the student-related factors affecting the school climate, (2) principals' perceptions of the teacher-related factors affecting the school climate, (3) principals' views on teachers' morale and commitment, and (4) principals' views on students' morale and commitment.

The student-level data are used to examine how the students' beliefs about themselves in math and their math achievement are related in Canada and Hong Kong-China respectively. The school-level data are involved to explore how the learning environment at school affects mean math achievement across schools and moderates the relationships between students' beliefs about themselves in math and their math achievement. The methods for analyzing data in the present study are described below in detail.

Descriptive Statistics

Descriptive statistics of the samples. The basic demographic information is reported for the two samples of Canada and Hong Kong-China, including sample sizes, the ages of the participants, and the numbers of boys and girls. The purpose of doing this is to better understand the two samples and to check whether there is obvious violation to the sample representation concerning the age of participants and the equal size of gender groups.

Descriptive statistics of the variables. The descriptive statistics of each variable should be stated, such as the mean, the standard deviation, the histogram, the maximum and minimum, and the skewness and kurtosis. It is also important to compare these

statistics between the two countries. Additionally, it is necessary to check the correlations between the variables at the student level and the correlations at the school level. If there is an extremely high relationship between two variables ($>.90$), it may be a good idea to include only one of them in the models. By doing so, the possible problem of multicollinearity can be avoided.

HLMs of Canada and Hong Kong-China

The software program HLM 6.0 is used to build models for Canada and Hong Kong-China. HLM provides researchers with a handy tool to analyze multilevel data, and it can handle plausible values and sample weights. Replicate weights are not used in this study although they are in the PISA 2003 dataset, because they do not substantially influence the results (Willms and Smith, 2005).

The first step is to build a null model for each of the two countries. The equations are:

$$\text{Student level: Math scores} = \beta_{0j} + r_{ij}$$

$$\text{School level: } \beta_{0j} = \gamma_{00} + u_{0j}$$

Null models enable researchers to know whether average school scores on the math test (β_{0j}) significantly vary across schools and how much the variance of math scores can be accounted by the school level through calculating $\rho = \tau_{00}/(\tau_{00} + \sigma^2)$. If null models show that math scores have variability both at the student and school levels, it is reasonable to build multilevel models and to see how much the variance of math scores decreases after the variables at two levels are controlled (Schreiber & Griffin, 2004).

The second step is to make a two-level model using student and school level

correlates for each of the two countries. The models focus on students' beliefs about themselves in mathematics at the student level, and the learning environment and school climate at the school level. The equations are shown as follows:

$$\text{Level 1: Math scores} = \beta_{0j} + \beta_{1j}(\text{Math self-efficacy}) + \beta_{2j}(\text{Math self-concept}) + r_{ij}$$

$$\begin{aligned} \text{Level 2: } \beta_{0j} = & \gamma_{00} + \gamma_{01}(\text{Teacher support}) + \gamma_{02}(\text{Disciplinary climate}) \\ & + \gamma_{03}(\text{Student behaviors}) + \gamma_{04}(\text{Teacher behaviors}) \\ & + \gamma_{05}(\text{Teachers' morale and commitment}) \\ & + \gamma_{06}(\text{Students' morale and commitment}) + u_{0j} \end{aligned}$$

$$\begin{aligned} \beta_{1j} = & \gamma_{10} + \gamma_{11}(\text{Teacher support}) + \gamma_{12}(\text{Disciplinary climate}) \\ & + \gamma_{13}(\text{Student behaviors}) + \gamma_{14}(\text{Teacher behaviors}) \\ & + \gamma_{15}(\text{Teachers' morale and commitment}) \\ & + \gamma_{16}(\text{Students' morale and commitment}) + u_{1j} \end{aligned}$$

$$\begin{aligned} \beta_{2j} = & \gamma_{20} + \gamma_{21}(\text{Teacher support}) + \gamma_{22}(\text{Disciplinary climate}) \\ & + \gamma_{23}(\text{Student behaviors}) + \gamma_{24}(\text{Teacher behaviors}) \\ & + \gamma_{25}(\text{Teachers' morale and commitment}) \\ & + \gamma_{26}(\text{Students' morale and commitment}) + u_{2j} \end{aligned}$$

After the first running of the models, non-significant variables are removed and then the models are run again. The output files demonstrate the final estimation of fixed effects and variance components. It is important to check whether the intercept (β_{0j}) and slopes (β_{1j} and β_{2j}) significantly vary from school to school. Significant school variations indicate that they are still significantly different across schools even after

controlling teacher support, disciplinary climate, student-related and teacher-related factors, and teachers' and students' morale and commitment. Student level error variance (σ^2) indicates how much the variance of math scores remains after student-level and school-level variables are accounted in the models.

The Comparison of the HLMs

The contexts of different countries can affect the relationships among students' beliefs about themselves in mathematics, learning environment at school, and math achievement, on student and school levels. Consequently, this study compares the Canada and Hong-Kong China on (a) whether self-concept and self-efficacy are significant at the student level; (b) the overall, across-school mean of math scores (γ_{00}), the average math self-concept slope (γ_{10}), and the average math self-efficacy slope (γ_{20}), (c) the influence of teacher support, disciplinary climate, student-related and teacher-related factors, and teachers' and students' morale and commitment on the average school scores and the math self-concept/math self-efficacy slopes ($\gamma_{01}, \gamma_{02}, \dots, \gamma_{06}; \gamma_{11}, \gamma_{12}, \dots, \gamma_{16}; \gamma_{21}, \gamma_{22}, \dots, \gamma_{26}$).

Summary of Methods

In order to explore the relationships among students' beliefs about themselves in mathematics, learning environment at school, and math achievement, in Canada and Hong Kong-China respectively, this study investigates the existing data collected from these two countries in the PISA 2003. In summary, the methods address the following questions:

- (1) What do the data look like? (Descriptive statistics)
- (2) Are there noticeable relationships between variables? (Correlations)
- (3) What are the HLMs for Canada and Hong-Kong China? (Null models and Intercept and Slope as Outcomes Models)
- (4) What are the differences between the HLMs for Canada and Hong-Kong China? (Comparison)

After the methods discussed above are implemented, the corresponding interpretations of the findings are provided in the later section. This research will help people better understand the differences in students' performance between the two countries through using HLM. The differences between the HLM models of Canada and Hong Kong-China may be the reflection of the two various educational systems and cultural values. The results of this study will be useful for governments and schools to make their policy decisions, which in turn, might improve students' academic achievement and the whole educational systems.

CHAPTER 4: RESULTS

The results of this study describe and evaluate the relationships among students' beliefs about themselves in mathematics, learning environment at school, and math achievement in Canada and Hong Kong-China. HLM was used to explore the relationships between students' beliefs about themselves in math (math self-concept and math self-efficacy) and their math achievement in Canada and Hong Kong-China respectively. Further exploration at the school level focused on how the learning environment at school (teacher support in math, the disciplinary climate in mathematics lessons, student-related and teacher-related factors affecting the school climate, teachers' and students' morale and commitment) affects average math achievement across schools and moderates the relationships between students' beliefs about themselves in math and their math achievement in Canada and Hong Kong-China separately. The results of the study are described and discussed in detail as follows.

Descriptive Statistics

Samples of Canada and Hong Kong-China

In total 27,953 students from 1,087 schools in Canada and 4,478 students from 145 schools in Hong Kong-China participated in the PISA 2003. The Canadian students are aged between 15.33 and 16.33, including 13,748 females and 13,469 males. The Hong Kong-Chinese sample consists of 2,259 females and 2,219 males aged from 15.25 to 16.33. These statistics are generally consistent with the PISA sampling standards concerning the age of participants and the equal size of gender groups. Consequently,

there is no obvious violation to the sample representation.

Mathematics Self-concept

Mathematics Self-concept, a scaled index with values centered at 0 and ranging from -3 to +3, was measured through the PISA 2003 Student Questionnaire. Positive values indicate positive self-concept in mathematics. The histograms of math self-concept for Canada and Hong Kong-China are shown in Figure 2 and Figure 3.

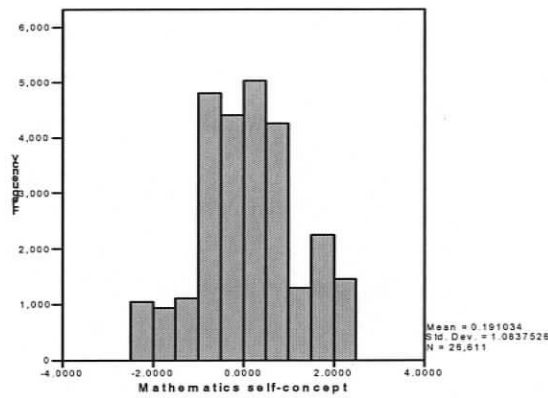


Figure 2. Histogram of Math Self-concept for Canada

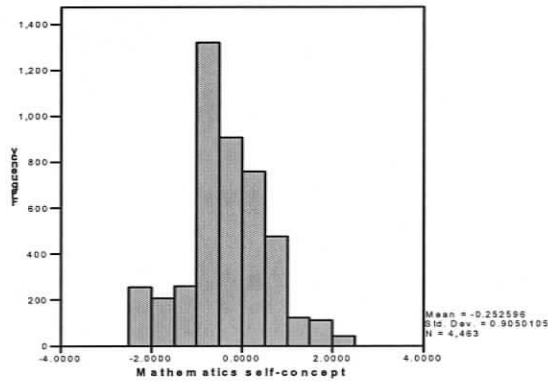


Figure 3. Histogram of Math Self-concept for Hong Kong-China

Table 1

Descriptive statistics of Math Self-concept for Canada and Hong Kong

Country	Minimum	Maximum	Mean	SD	Skewness	Kurtosis
Canada	-2.12	2.42	0.19	1.08	0.03	-0.32
Hong Kong	-2.12	2.42	-0.25	0.91	0.08	0.09

According to Figure 2 and Figure 3, Math Self-concept is roughly normally distributed for both Canada and Hong Kong-China. Table 1 demonstrates the maximum, minimum, mean, standard deviation, skewness, and kurtosis of Mathematics Self-concept for Canada and Hong Kong-China. The maximum and minimum are the same in the two countries. Canadian students on average showed higher levels of math self-concept (.19) than Hong Kong-Chinese peers (-.25). This difference $(.19 - (-.25) = .44)$ is almost equal to $1/2$ standard deviation. There is no obvious violation to the normal distribution of Mathematics Self-concept according to the values of skewness and kurtosis.

Mathematics Self-efficacy

Mathematics Self-efficacy was measured through the PISA 2003 Student Questionnaire. It is a scaled index with values centered at 0 and ranging from -3 to $+3$. Positive scores represent high levels of self-efficacy in mathematics. The histograms of Mathematics Self-efficacy for Canada and Hong Kong-China are shown in Figure 4 and Figure 5. Table 2 demonstrates the maximum, minimum, mean, standard deviation, skewness, and kurtosis of Mathematics Self-efficacy for Canada and Hong Kong-China.

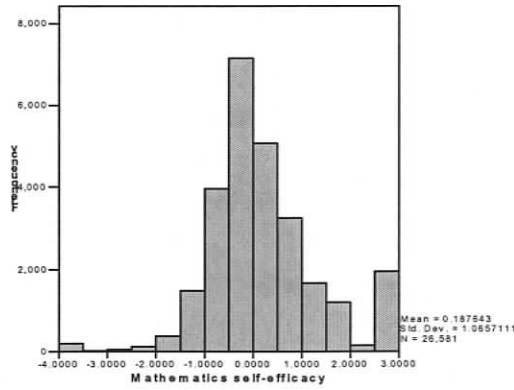


Figure 4. Histogram of Math Self-efficacy for Canada

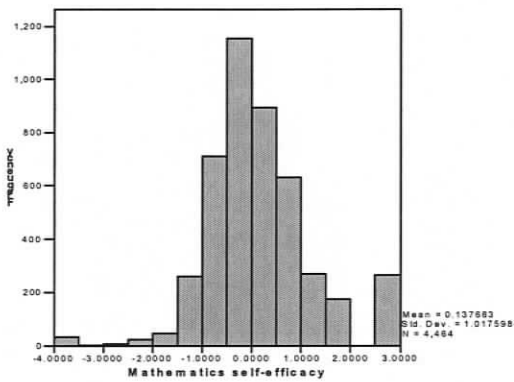


Figure 5. Histogram of Math Self-efficacy for Hong Kong-China

Table 2

Descriptive statistics of Math Self-efficacy for Canada and Hong Kong

Country	Minimum	Maximum	Mean	SD	Skewness	Kurtosis
Canada	-3.89	2.53	0.19	1.07	0.24	1.16
Hong Kong	-3.89	2.53	0.14	1.02	0.14	1.64

According to the Figure 4 and Figure 5, Math Self-efficacy is roughly normally distributed for both Canada and Hong Kong-China. In Table 2, the minimum and maximum are the same in the two countries. Canadian students reported slightly higher math self-efficacy (.19) than Hong Kong-Chinese students (.14) on average. The values

of skewness and kurtosis generally support the normal distribution of Mathematics Self-efficacy.

Teacher Support in Mathematics

Teacher Support, a scaled index with values centered at 0 and ranging from -3 to +3, was measured through the PISA 2003 Student Questionnaire. Positive scores indicate students' perceptions of higher levels of teacher support in math. The histograms of Teacher Support for Canada and Hong Kong-China are shown in Figure 6 and Figure 7. Table 3 demonstrates the maximum, minimum, mean, standard deviation, skewness, and kurtosis of Teacher Support for Canada and Hong Kong-China.

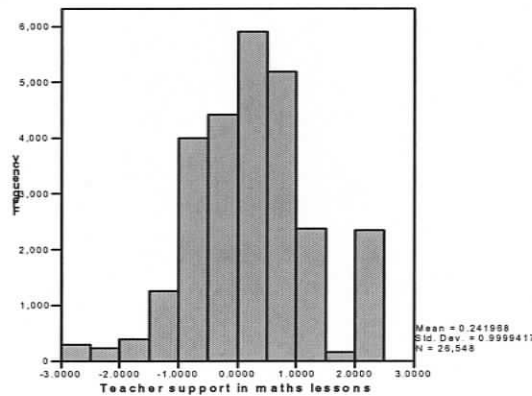


Figure 6. Histogram of Teacher Support for Canada

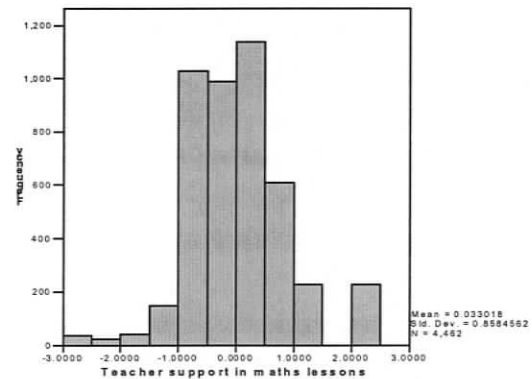


Figure 7. Histogram of Teacher Support for Hong Kong-China

Table 3

Descriptive statistics of Teacher Support for Canada and Hong Kong

Country	Minimum	Maximum	Mean	SD	Skewness	Kurtosis
Canada	-2.92	2.10	0.24	1.00	-0.17	0.28
Hong Kong	-2.92	2.10	0.03	0.86	0.18	0.99

According to Figure 6 and Figure 7, Teacher Support is roughly normally distributed for both Canada and Hong Kong-China. In Table 3, the minimum and maximum are the same in the two samples. Canadian students perceived more support from teachers (.24) than Hong Kong-Chinese students (.03) on average. There is no obvious violation to the normal distribution of Teacher Support according to the values of skewness and kurtosis.

Disciplinary Climate in Mathematics Lessons

Disciplinary Climate was measured through the PISA 2003 Student Questionnaire. Disciplinary Climate is a scaled index with values centered at 0 and ranging from -3 to +3. Positive scores indicate students' perceptions of a positive disciplinary climate. The histograms of Disciplinary Climate for Canada and Hong Kong-China are shown in Figure 8 and Figure 9. Table 4 demonstrates the maximum, minimum, mean, standard deviation, skewness, and kurtosis of Disciplinary Climate for Canada and Hong Kong-China.

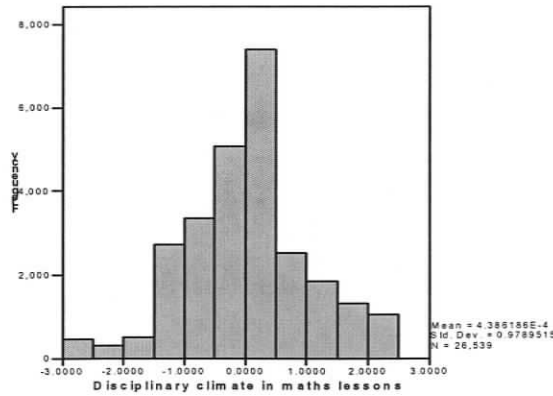


Figure 8. Histogram of Disciplinary Climate for Canada

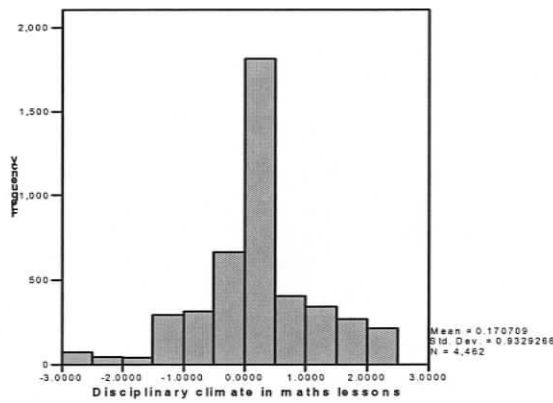


Figure 9. Histogram of Disciplinary Climate for Hong Kong-China

Table 4

Descriptive statistics of Disciplinary Climate for Canada and Hong Kong

Country	Minimum	Maximum	Mean	SD	Skewness	Kurtosis
Canada	-2.74	2.35	0.00	0.98	0.06	0.49
Hong Kong	-2.74	2.35	0.17	0.93	-0.08	1.20

According to the histograms on Figure 8 and Figure 9, Disciplinary Climate is roughly normally distributed for both Canada and Hong Kong-China. Table 4 shows that the minimums and maximums of the two samples are the same. Hong Kong-Chinese students perceived a better disciplinary climate in mathematics lessons (.17) than

Canadian students (.00) on average. The values of skewness and kurtosis generally support the normal distribution of Disciplinary Climate for the two countries.

Student-Related Factors Affecting the School Climate

School principals were asked to report their perceptions of student-related factors affecting the school climate in the PISA 2003 School Questionnaire. The answers from principals were combined to a composite index Student Behaviors. Values above zero reflect that in school principals' opinions students' behaviors hinder learning to a lesser extent, while values below zero reflect that students' behaviors hinder learning to a greater extent, compared to the OECD average. The histograms of Student Behaviors for Canada and Hong Kong-China are shown in Figure 10 and Figure 11. Table 5 demonstrates the maximum, minimum, mean, standard deviation, skewness, and kurtosis of Student Behaviors for Canada and Hong Kong-China.

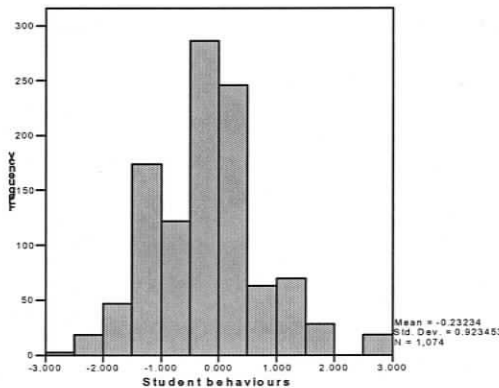


Figure 10. Histogram of Student Behaviors for Canada

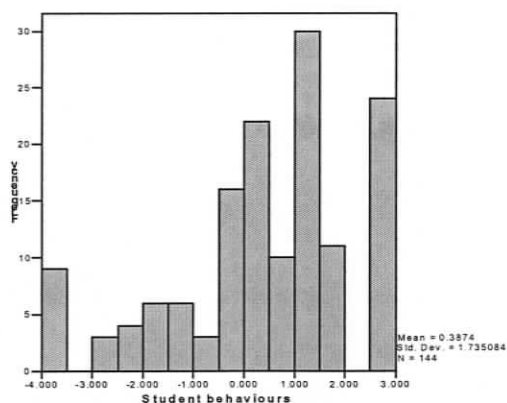


Figure 11. Histogram of Student Behaviors for Hong Kong-China

Table 5

Descriptive statistics of Student Behaviors for Canada and Hong Kong

Country	Minimum	Maximum	Means	SD	Skewness	Kurtosis
Canada	-2.87	2.61	-0.23	0.92	0.47	0.77
Hong Kong	-3.61	2.61	0.39	1.74	-0.74	-0.08

According to Figure 10 and Figure 11, Student Behaviors is roughly normally distributed for both Canada and Hong Kong-China. As shown in Table 5, on average principals in Hong Kong-China reported their perceptions of better students' behaviors (.39), compared to Canadian principals (-.23). This difference $(.39 - (-.23) = .62)$ is more than 1/2 standard deviation. The values of skewness and kurtosis support that there is no obvious violation to the normal distribution of Student Behaviors for the two countries.

Teacher-Related Factors Affecting the School Climate

Principals reported their perceptions of teacher-related factors affecting the school climate in the PISA 2003 School Questionnaire. The responses from principals were combined to a composite index – Teacher Behaviors. Positive values indicate that in

principals' opinions, teacher-related factors affecting the school climate hinder learning to a lesser extent, while negative values reflect that teachers' behaviors hinder learning to a greater extent, compared to the OECD average. The histograms of Teacher Behaviors for Canada and Hong Kong-China are shown in Figure 12 and Figure 13. Table 6 demonstrates the maximum, minimum, mean, standard deviation, skewness, and kurtosis of Teacher Behaviors for Canada and Hong Kong-China.

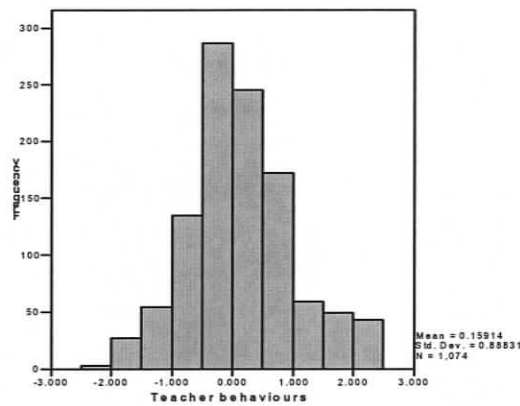


Figure 12. Histogram of Teacher Behavior for Canada

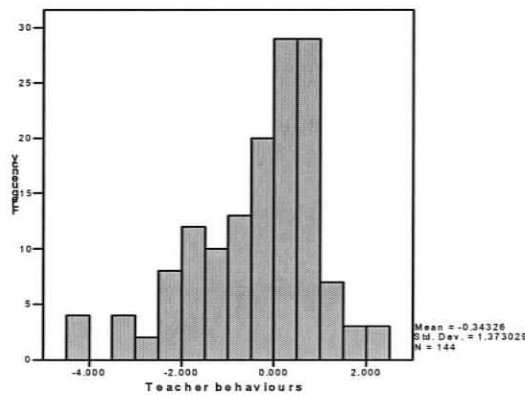


Figure 13. Histogram of Teacher Behaviors for Hong Kong-China

Table 6

Descriptive statistics of Teacher Behaviors for Canada and Hong Kong

Country	Minimum	Maximum	Means	SD	Skewness	Kurtosis
Canada	-2.44	2.49	0.16	0.89	0.51	0.46
Hong Kong	-4.21	2.49	-0.34	1.37	-0.76	0.51

According to Figure 12 and Figure 13, Teacher Behaviors is roughly normally distributed for both Canada and Hong Kong-China. Principals in Canada perceived better teacher behaviors in their schools (.16) than principals in Hong Kong-China (-.34) on average, which is about 1/2 standard deviation difference (.16-(-.34) = .5). There is no obvious violation to the normal distribution of Teacher Behaviors according to the values of skewness and kurtosis.

Students' Morale and Commitment

School principals were asked to respond how strongly they agreed or disagreed with the four statements concerning the students' morale and commitment in their schools in the PISA 2003 School Questionnaire. An index of principals' perceptions of students' morale and commitment (Student Morale) was created with an average of zero and a standard deviation of one. Higher index values indicate greater perceived morale and commitment. The histograms of Student Morale for Canada and Hong Kong-China are shown in Figure 14 and Figure 15. Table 7 demonstrates the maximum, minimum, mean, standard deviation, skewness, and kurtosis of Student Morale for Canada and Hong Kong-China.

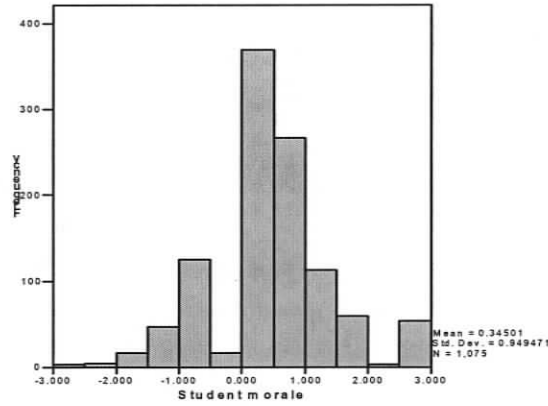


Figure 14. Histogram of Student Morale for Canada

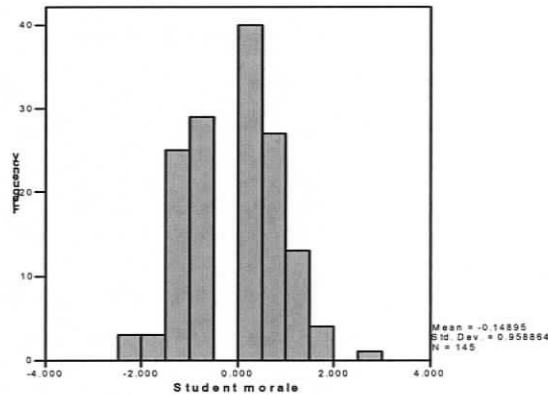


Figure 15. Histogram of Student Morale for Hong Kong-China

Table 7

Descriptive statistics of Student Morale for Canada and Hong Kong

Country	Minimum	Maximum	Means	SD	Skewness	Kurtosis
Canada	-2.77	2.59	0.35	0.95	0.21	0.57
Hong Kong	-2.15	2.59	-0.15	0.96	0.14	-0.39

According to Figure 14 and Figure 15, Student Morale is roughly normally distributed for both Canada and Hong Kong-China. Principals in Canada perceived greater students' morale and commitment (.35) than Chinese principals (-.15) on average, which is about 1/2 standard deviation difference (.35-(-.15) = .5). There is no obvious

violation to the normal distribution of Student Morale according to the values of skewness and kurtosis.

Teachers' Morale and Commitment

Based on principals' responses in the PISA 2003 School Questionnaire, an index of principals' perceptions of teachers' morale and commitment (Teacher Morale) was created with an average of zero and a standard deviation of one. Higher index values indicate greater perceived morale and commitment. The histograms of Teacher Morale for Canada and Hong Kong-China are shown in Figure 16 and Figure 17. Table 8 demonstrates the maximum, minimum, mean, standard deviation, skewness, and kurtosis of Teacher Morale for Canada and Hong Kong-China.

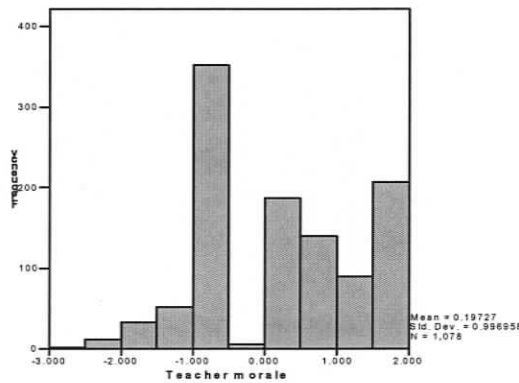


Figure 16. Histogram of Teacher Morale for Canada

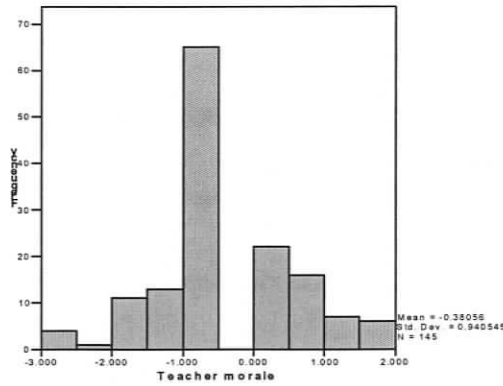


Figure 17. Histogram of Teacher Morale for Hong Kong-China

Table 8

Descriptive statistics of Teacher Morale for Canada and Hong Kong

Country	Minimum	Maximum	Means	SD	Skewness	Kurtosis
Canada	-2.81	1.65	0.20	1.00	-0.08	-0.78
Hong Kong	-2.81	1.65	-0.38	0.94	-0.12	0.22

According to Figure 16 and Figure 17, Teacher Morale is roughly normally distributed for both Canada and Hong Kong-China with the mean around zero. School principals in Canada reported greater teachers' morale and commitment (.20) than Chinese principals (-.38) on average. This difference (.20-(-.38) = .58) is larger than 1/2 standard deviation. There is no obvious violation to the normal distribution of Teacher Morale according to the values of skewness and kurtosis.

Mathematics Achievement

For each student who participated in the PISA 2003, there are five plausible values (PV1math – PV5math) in the datasets to indicate his/her math achievement. The scores were scaled with a mean of 500 and a standard deviation of 100. The histograms of the

math scores for Canada and Hong Kong-China are shown in Figure 18 and Figure 19.

Table 9 demonstrates the maximum, minimum, mean, standard deviation, skewness, and

kurtosis of math scores for Canada and Hong Kong-China.

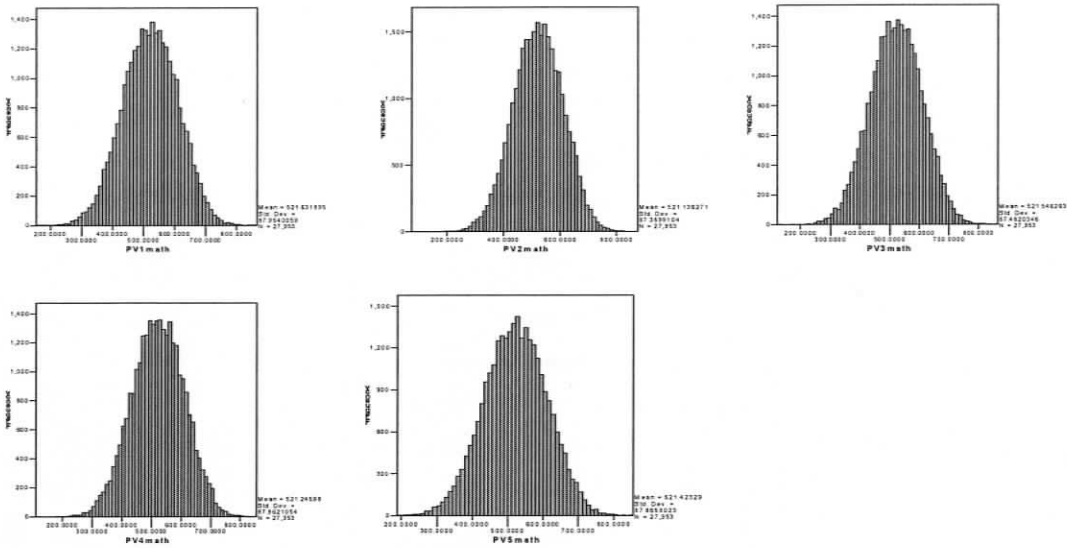


Figure 18. Histogram of the plausible values of math scores for Canada

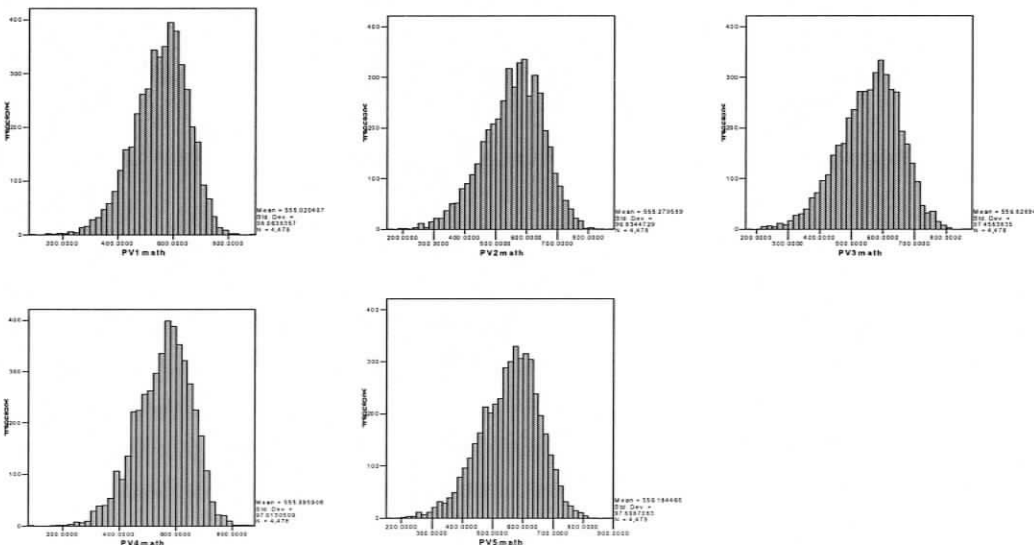


Figure 19. Histogram of the plausible values of math scores for Hong Kong-China

Table 9

Descriptive statistics of math scores for Canada and Hong Kong-China

Country		Minimum	Maximum	Mean	SD	Skewness	Kurtosis
Canada	PV1math	160.34	859.28	521.63	87.95	-0.06	-0.17
	PV2math	83.14	866.83	521.14	87.39	-0.07	-0.13
	PV3math	123.96	856.47	521.55	87.48	-0.06	-0.14
	PV4math	119.75	853.28	521.25	87.86	-0.08	-0.14
	PV5math	191.03	844.48	521.42	87.87	-0.06	-0.14
Hong Kong	PV1math	95.61	881.09	555.02	98.06	-0.46	0.31
	PV2math	159.87	870.96	555.28	96.83	-0.41	0.14
	PV3math	174.20	877.19	556.83	97.46	-0.39	0.12
	PV4math	95.61	878.75	556.00	97.01	-0.42	0.19
	PV5math	159.87	893.78	556.18	97.90	-0.39	0.18

According to the histograms on Figure 18 and Figure 19, all the five plausible values of math scores are roughly normally distributed for both Canada and Hong Kong-China. Table 9 shows that Canada and Hong Kong-China are two high performing countries, compared to the OECD average score of 500. Moreover, on average Hong Kong-Chinese students outperformed Canadian students in math. There is no obvious violation to the normal distributions of all the five plausible values of math scores according to the corresponding skewness and kurtosis.

Correlations

The correlations between variables at the student level and the school level were analyzed by SPSS 13.0. Since the five plausible values of math scores for each student are quite similar, only PV1math is used here. The results for Canada and Hong Kong-China are shown in Table 10, 11, 12, and 13 as below.

Table 10

Correlations between variables at the student level for Canada

	Math self-concept	Math self-efficacy	PV1math
Math self-concept	1		
Math self-efficacy	.55(**)	1	
PV1math	.46(**)	.54(**)	1

** Pearson correlation is significant at the 0.01 level (2-tailed).

Table 11

Correlations between variables at the school level for Canada

	Teacher Support	Disciplinary Climate	Student Behavior	Teacher Behavior	Teacher Morale	Student Morale
Teacher Support	1					
Disciplinary Climate	.41(**)	1				
Student Behavior	.16(**)	.25(**)	1			
Teacher Behavior	.13(**)	.18(**)	.61(**)	1		
Teacher Morale	.07(*)	.14(**)	.32(**)	.44(**)	1	
Student Morale	.04	.12(**)	.43(**)	.30(**)	.45(**)	1

** Pearson correlation is significant at the 0.01 level (2-tailed).

* Pearson correlation is significant at the 0.05 level (2-tailed).

Table 12

Correlations between variables at the student level for Hong Kong-China

	Math self-concept	Math self-efficacy	PV1math
Math self-concept	1		
Math self-efficacy	.51(**)	1	
PV1math	.35(**)	.56(**)	1

** Pearson correlation is significant at the 0.01 level (2-tailed).

Table 13

Correlations between variables at the school level for Hong Kong-China

	Teacher Support	Disciplinary Climate	Student behavior	Teacher behavior	Teacher Morale	Student Morale
Teacher Support	1					
Disciplinary Climate	.50(**)	1				
Student Behaviors	.15	.12	1			
Teacher Behaviors	.10	-.01	.87(**)	1		
Teacher Morale	.24(**)	.23(**)	.33(**)	.34(**)	1	
Student Morale	.33(**)	.44(**)	.26(**)	.23(**)	.62(**)	1

** Correlation is significant at the 0.01 level (2-tailed).

At the student level, for both countries, math self-concept and math self-efficacy are moderately related to math achievement ($r = .46$ and $.54$ in Canada, $r = .35$ and $.56$ in

Hong Kong-China, $p < .01$). Math self-efficacy has a stronger association with math achievement than math self-concept. There are positive relationships between math self-concept and math self-efficacy ($r = .55$ in Canada, $r = .51$ in Hong Kong-China, $p < .01$).

At the school level, for Canada, all the relationships between variables are positive and significant only except the one between teacher support and students' morale ($r = .04$). The strongest correlation is between teachers' behaviors and students' behaviors ($r = .61$, $p < .01$). For Hong Kong-China, most variables are significantly and positively associated with each other. Again the relationship between teachers' behaviors and students' behaviors is the highest ($r = .87$, $p < .01$).

Summary of Descriptive Statistics

The samples of Canada and Hong Kong-China are representative of the population who are still at school and aged between 15 years 3 months and 16 years 2 months at the time of assessment, regardless of the grade, institutions, and full-time or part-time education. Both samples consist of about equal numbers of boys and girls. All the variables at the student level and the school level are roughly normally distributed. Hong Kong-Chinese students outperformed their Canadian peers on the mathematics assessment. However, students in Hong Kong-China evaluated themselves lower in math self-concept and math self-efficacy than Canadian students. Hong Kong-Chinese students perceived a better disciplinary climate but less teacher support, compared to Canadian students. In general, Canadian principals have relatively more positive perceptions about

the learning environment at school than Hong Kong-Chinese principals. For both countries, students' math self-concept and math self-efficacy are moderately and positively related to their math achievement. Most variables about the learning environment at school are positively associated with each other.

HLM Results

Null Models

HLM 6.02 is the software program applied to conduct HLMs in the present study.

The equations of Null Models are:

$$\text{Student level: Math scores} = \beta_{0j} + r_{ij}$$

$$\text{School level: } \beta_{0j} = \gamma_{00} + u_{0j}$$

The output of the Null Models for Canada and Hong Kong-China are demonstrated in Table 14 and Table 15.

Table 14

The output of the null model for Canada

Fixed Effect	Standard Coefficient
For INTERCEPT1, β_{0j}	
Intercept2, γ_{00}	531.20
Random Effect	Variance Component
INTERCEPT1, U0	1452.61
level-1, R	5723.91

Table 14 shows that the average school scores on the math assessment significantly vary across schools in Canada. About 20.24% of the variance of math scores can be

accounted by the school level (intra-class correlation $\rho = 1452.61/(1452.61+5723.91)$).

Table 15

The output of the null model for Hong Kong-China

Fixed Effect	Standard Coefficient
For INTERCEPT1, β_{0j}	
Intercept2, γ_{00}	547.40
Random Effect	Variance Component
INTERCEPT1, U_0	4931.73
level-1, R	5174.62

Table 15 shows that the average school scores on the math assessment significantly vary across schools in Hong Kong-China. About 48.80% of the variance of math scores can be accounted by the school level (intra-class correlation $\rho = 4931.73/(4931.73+5174.62)$). According to the intra-class correlations for the two countries, the proportion of students' achievement variance attributed by schools in Canada (20.24%) is less than half of the one in Hong Kong-China (48.80%), which means that the effects of school characteristics on students' math achievement in Canada are more homogenous than Hong Kong-China.

Intercept and Slope as Outcomes Models

The student-level and school-level variables are included in the models. After running the models and removing non-significant variables, the final models of Canada are:

Level 1: Math scores = $\beta_{0j} + \beta_{1j}(\text{Math Self-efficacy}) + \beta_{2j}(\text{Math Self-concept}) + r_{ij}$

Level 2: $\beta_{0j} = \gamma_{00} + \gamma_{01}(\text{Students' Morale}) + \gamma_{02}(\text{Teacher Support})$

$+ \gamma_{03}(\text{Disciplinary Climate}) + u_{0j}$

$\beta_{1j} = \gamma_{10} + u_{1j}$

$\beta_{2j} = \gamma_{20} + u_{2j}$

The output of the final models for Canada is demonstrated in Table 16.

Table 16

The output of the final models for Canada

Fixed Effect	Standard Coefficient
For INTERCEPT1, β_{0j}	
Intercept2, γ_{00}	524.12
Student Morale, γ_{01}	10.92
Teacher Support, γ_{02}	-15.38
Disciplinary Climate, γ_{03}	22.92
For Self-efficacy slope, β_{1j}	
Intercept2, γ_{10}	29.73
For Self-concept slope, β_{2j}	
Intercept2, γ_{20}	19.12
Random Effect	Variance Component
INTERCEPT1, U0	789.27
Self-efficacy slope, U1	100.07
Self-concept slope, U2	36.54
level-1, R	3628.26

According to Table 16, in the student-level model, students who have higher math self-efficacy and math self-concept are predicted to perform better in math than students who have lower math self-efficacy and math self-concept. As the value of Math

Self-efficacy increases by one unit (about one standard deviation), the students tend to have 29.73 points higher on the math assessment on average when other variables are constant. Moreover, one unit (about one standard deviation) increase in Math Self-concept associates with 19.12 points higher in math scores on average given that other variables are fixed.

In the school-level model, for the intercept (β_{0j}) which indicates the average school scores, Students' Morale and Disciplinary Climate are positively associated with average school scores. As Students' Morale increases by one unit (about one standard deviation), the school average score increases by 10.92 points when other variables are fixed. As Disciplinary Climate increases by one unit (about one standard deviation), the school average score increases by 22.92 points when other variables are held constant. A surprising finding is that Teacher Support is negatively related to average school scores: one unit (about one standard deviation) increase in Teacher Support associates with 15.38 point decrease in average school scores given that other variables are fixed. One possible reason for this is that more teacher support is likely to be provided to the students in schools with low academic achievement or learning disabilities. Further studies are needed to explore this negative relationship between teacher support and average school scores in the future. There is significant school variation in average school scores after controlling students' morale, disciplinary climate, and teacher support. The self-efficacy slopes and self-concept slopes both significantly vary across schools although there are no significant school correlates. The variance of math scores at the student level drops

from 5723.91 in the null models to 3628.26 in the final models (36.61% drop).

The final models of Hong Kong-China are:

$$\text{Level 1: Math scores} = \beta_{0j} + \beta_{1j} (\text{Math Self-efficacy}) + \beta_{2j} (\text{Math Self-concept}) + r_{ij}$$

$$\text{Level 2: } \beta_{0j} = \gamma_{00} + \gamma_{01} (\text{Students' Morale}) + \gamma_{02} (\text{Student Behaviors})$$

$$+ \gamma_{03} (\text{Teacher Support}) + \gamma_{04} (\text{Disciplinary Climate}) + u_{0j}$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11} (\text{Students' Morale})$$

$$\beta_{2j} = \gamma_{20} + \gamma_{21} (\text{Teachers' Morale})$$

The output of the final models for Hong Kong-China is demonstrated in Table 17.

Table 17

The output of the final models for Hong Kong-China

Fixed Effect	Standard Coefficient
For INTERCEPT1, β_{0j}	
Intercept2, γ_{00}	540.77
Student Morale, γ_{01}	24.32
Student Behaviors, γ_{02}	4.43
Teacher Support, γ_{03}	-46.55
Disciplinary Climate, γ_{04}	88.98
For Self-efficacy slope, β_{1j}	
Intercept2, γ_{10}	27.74
Student Morale, γ_{11}	-4.91
For Self-concept slope, β_{2j}	
Intercept2, γ_{20}	13.89
Teacher Morale, γ_{21}	3.71
Random Effect	Variance Component
INTERCEPT1, U0	1575.76
level-1, R	4071.50

Table 17 shows that, at the student level, students who have higher math self-efficacy and math self-concept are predicted to perform better in math than students who have lower math self-efficacy and math self-concept. As the value of Math Self-efficacy increases by one unit (about one standard deviation), the students tend to have 27.74 points higher on the math assessment on average when other variables are constant. Moreover, one unit (about one standard deviation) increase in Math Self-concept associates with 13.89 points higher in math scores on average given that other variables are fixed.

At the school level in Table 17, for the intercept (β_{0j}) which indicates average school scores, Students' Morale, Students' Behaviors, and Disciplinary Climate are positively associated with average school scores, while Teacher Support is negatively related to average school scores. As Students' Morale increases by one unit (about one standard deviation), the school average score increases by 24.32 points when other variables are fixed. As Disciplinary Climate increases by one unit (about one standard deviation), the school average score increases by 88.98 points when other variables are held constant. One unit (about one standard deviation) increase in Students' Behaviors associates with 4.43 point increase in average school scores when other variables are fixed, which is a very small effect considering that the average math score of Hong Kong is around 550. The same as Canada, in Hong Kong Teacher Support is negatively related to average school scores: one unit (about one standard deviation) increase in Teacher Support associates with 46.55 point decrease in average school scores given that other

variables are fixed. Again the possible reason for this is that more teacher support is likely to be provided to the students in schools with low academic achievement or learning disabilities. There is significant school variation in average school scores after controlling students' morale, students' behaviors, teacher support, and disciplinary climate. For the self-efficacy slope, the increase in Students' Morale reduces the effects of math self-efficacy on math achievement. This indicates that in the schools where students have higher morale, the math achievement gap between students with different levels of math self-efficacy becomes smaller. The self-efficacy slopes are not significantly different from school to school after controlling students' morale. The increase in Teachers' Morale strengthens the self-concept slope, which means that in schools with higher teachers' morale, the differences of math achievement between students with various levels of math self-concept become more obvious. There is no significant school variation in self-concept slopes after conditioning teachers' morale. The variance of math scores at the student level drops from 5174.62 in the Null Models to 4071.50 in the final models (21.32% reduction).

Comparison between Two Countries

Table 18

Research findings in the null models for Canada and Hong Kong-China

	Canada	Hong Kong-China
γ_{00}	531.20	547.40
τ_{00}	1452.61	4931.73
σ^2	5723.91	5174.62
ρ	20.24%	48.80%

Table 19

Research findings in the final models for Canada and Hong Kong-China

		Canada	Hong-Kong
			China
Student level	Math self-efficacy	29.73	27.74
	Math self-concept	19.12	13.89
School level: intercept	Overall mean	524.12	540.77
	Teacher support	-15.38	-46.55
	Disciplinary climate	22.92	88.98
	Student behaviors	N/A	4.43
	Teacher behaviors	N/A	N/A
	Teachers' morale and commitment	N/A	N/A
	Students' morale and commitment	10.92	24.32
	School variation	Significant	Significant
School level: Math self-efficacy slope	Teacher support	N/A	N/A
	Disciplinary climate	N/A	N/A
	Student behaviors	N/A	N/A
	Teacher behaviors	N/A	N/A
	Teachers' morale and commitment	N/A	N/A
	Students' morale and commitment	N/A	-4.91
	School variation	Significant	Not significant
	School level: Math self-concept slope	Teacher support	N/A
Disciplinary climate		N/A	N/A
Student behaviors		N/A	N/A
Teacher behaviors		N/A	N/A
Teachers' morale and commitment		N/A	3.71
Students' morale and commitment		N/A	N/A
School variation		Significant	Not significant

Table 18 demonstrates the research findings in the null models for Canada and Hong Kong-China. The proportion of students' achievement variance attributable to schools in Canada (0.20) is less than half of the one in Hong Kong-China (0.49), which means that the effects of school characteristics on students' math achievement in Canada are more homogenous than Hong Kong-China.

Table 19 provides a summary of the research findings in the final models for Canada and Hong Kong-China. There are several similarities between Canada and Hong Kong-China in the final models. First, math self-concept and math self-efficacy are significantly and positively related to math achievement. Second, students' morale and disciplinary climate within schools are significant correlates positively associated with school math scores; teacher support is significantly and negatively related to school average scores. Third, school average scores still significantly vary from school to school after controlling the variables. Fourth, there is still much unaccounted variance of math scores in the final models.

Many differences also exist between Canada and Hong Kong-China in the final models. First, Hong Kong-China has a higher overall average score than Canada by about 20 points. Second, Students' Behaviors is significantly and positively related to average school scores in Hong Kong-China, but not significant in Canada. Third, the average self-efficacy slope and the average self-concept slope in Canada are steeper than Hong Kong-China. Fourth, students' morale school average significantly reduces the effect of self-efficacy on math achievement in Hong Kong, but not in Canada. Fifth, teachers'

morale significantly enhances the self-concept slope in Hong Kong-China, but not in Canada. Sixth, in Hong Kong there is no significant school variation in self-efficacy slopes after controlling students' morale and no significant school variation in self-concept slopes after conditioning teachers' morale; in Canada there is significant school variation in self-efficacy slopes and self-concept slopes although the slopes do not have any significant school correlates.

CHAPTER 5: SUMMARY, DISCUSSION, AND CONCLUSION

Summary

The primary aim of this study was to (1) examine the relationships among students' beliefs about themselves in mathematics (including math self-concept and math self-efficacy), learning environment at school (including teacher support, disciplinary climate, students' and teachers' behaviors, and students' and teachers' morale), and math achievement, at student and school levels, in Canada and Hong Kong-China; (2) compare the differences in those relationships between the two countries; and (3) make recommendations for improving students' math achievement in the two countries according to the findings of this study. The data come from the OECD's PISA 2003 database and HLM was used to analyze these data.

The null models show that for the PISA 2003 math results, the proportion of students' achievement variance attributable to schools in Canada (0.20) is less than half of the one in Hong Kong-China (0.49), which means that the effects of school characteristics on students' math achievement in Canada are more homogenous than Hong Kong-China.

According to the two-level models, at the student level, math self-efficacy and math self-concept are the significant correlates influencing students' performance for both Canadian and Hong Kong-Chinese students. At the school level, for the intercept β_{0j} , both countries have school average students' morale and disciplinary climate significantly positively related to school average scores, and teacher support negatively related to

school average scores; Hong Kong has an additional significant school correlate—student behaviors. For the math self-efficacy slope, the average self-efficacy slope (29.73) in Canada is marginally steeper than Hong Kong-China (27.74); students' morale, as reported by school principals, has a significantly negative relationship to the self-efficacy effect in Hong Kong (-4.91), but not in Canada; in Hong Kong there is no significant school variation in self-efficacy slopes after controlling students' morale, but in Canada there is significant school variation in self-efficacy slopes although the slopes do not have any significant school correlates. For the math self-concept slope, the average self-concept slope (19.12) in Canada is steeper and unconditional than Hong Kong-China conditioned by teacher morale (13.89); teachers' morale significantly makes the self-concept effect stronger in Hong Kong, but not in Canada; in Hong Kong self-concept slopes do not significantly vary across schools after controlling teachers' morale, but in Canada there is significant school variation in self-concept slopes although the slopes do not have any significant school correlates.

In sum, according to the results of this study, school learning environment has more effect on school math achievement in Hong Kong-China than in Canada. Canada has stronger relationships between students' self-beliefs in math and their math performance than Hong Kong-China. School variation of self-efficacy slopes and self-concept slopes are accountable by school learning environment in Hong Kong-China, but not in Canada.

Discussion

Self-Beliefs and Math Achievement in the Two Countries

Within Canada and Hong Kong-China, more positive self-beliefs in math are associated with better math performance. Because Hong Kong-Chinese students outperformed Canadian students on the math assessment, Hong Kong-Chinese students might be expected to report more positive beliefs about themselves in mathematics than Canadian students. However, students in Hong Kong-China evaluated themselves more negatively in math self-concept (-.25) and math self-efficacy (.14) than Canadian students (.19 for both math self-concept and math self-efficacy). One of the possible reasons for this is the culture of Chinese interpersonal behaviors. In China, self-effacement is socially desirable in order to enhance harmony in social relations (Bond, Leung, & Wan, 1982). It is possible that the items on the questionnaire about students' beliefs about themselves in math activate the self-effacing tendency of Chinese students, therefore lowering their responses on the scale. On the opposite, North American societies are characterized by a highly individualistic orientation, which may foster a heightened self-evaluation (Kwok & Lai, 1993).

Many other factors, besides self-efficacy and self-concept, also influence academic achievement. In Hong Kong-China, the importance of exams, pressure from parents and teachers, social emphases towards education, and so on, externally motivate and force students to study hard. This may explain to some extent why Hong Kong-Chinese students reported lower levels of self-beliefs in math but performed better on the math

assessment than Canadian students.

Intra-Class Correlations

In accordance with the intra-class correlations, the proportion of students' achievement variance attributable to schools in Canada (0.20) is less than half of the one in Hong Kong-China (0.49), which means that the effects of school characteristics on students' math achievement in Canada are more homogenous than Hong Kong-China. One possible explanation of this would be the effects of the different educational systems in the two countries. In Hong Kong-China, all kinds of tests and evaluation for the purpose of selecting students since elementary schools lead to a huge variety of average academic achievement across schools. Every student wants to go to the best schools. Schools with excellent reputation and abundant resources have many more applicants than they can accept, therefore they set high admission standards in order to admit the most outstanding students, which in turn keeps average academic achievement of those schools top ranked. The remaining schools can only accept the students with lower academic performance. In the PISA 2003 School Questionnaire, most principals in Hong Kong-China reported that their schools consider students' academic records as a prerequisite or a high priority for admittance at school, while residence in a particular area is the most important factor when students are admitted to Canadian schools (OECD, 2004).

The Relationships in the Final Models

The results from the final models are generally consistent with theories and prior

research findings. Both in Canada and Hong-Kong China, math self-concept and math self-efficacy are positively related to students' math achievement. Math self-efficacy has a stronger association with math achievement than math self-concept in Hong Kong and Canada. Moreover, some indicators of school learning environment affect average school scores and moderate the relationships between students' self-beliefs in math and their math achievement.

The relationships between students' beliefs about themselves in math and their mathematics achievement are more positive for Canadian students than Hong Kong-Chinese students on average. This suggests that math self-concept and math self-efficacy may not be as important for Hong Kong-Chinese students as for Canadian students in their development of math skills and knowledge.

Recommendations

Canada and Hong Kong-China are two high performing countries in the PISA 2003. Based on the findings of this study, the recommendations about how to further improve students' math performance in these two countries are provided here.

Promoting self-efficacy. Since the positive relationships between self-efficacy and mathematics achievement are relatively strong in both countries, it is important for students to develop and promote their self-efficacy. Schunk (1994, 1995b) suggested that emphasizing learning goals (goals of learning how to solve problems), rather than performance goals (goals of solving problems), raises self-efficacy for learning. Bandura (1993) believed that learning environments which accept the belief that ability may be

acquired, and de-emphasize competition and social comparison, will promote self-efficacy building and academic achievement. Teachers should pay as much attention to students' perceptions of competence as to actual competence (Pajares & Kranzler, 1995). For both two countries, it is significant for school practitioners to help students develop their positive self-beliefs in mathematics. Teachers and parents need to realize the importance of verbal persuasion (Bandura, 1986). They should often discuss with students about students' improvement in math, the possibility of taking advanced mathematics courses, careers related to mathematics, how to succeed in mathematics, and so forth. Randhawa, Beamer, and Lundberg (1993) suggested innovative instructional techniques which emphasize more process-related understanding through discussion rather than the correct answer as the end. They believed that these approaches would reduce the impact of negative feedback for an incorrect answer and encourage risk-taking behaviors. Furthermore, an environment, which promotes exploratory and explanatory learning without the needs to always be correct, enhances students' self-esteem and self-efficacy (Pressley et al., 1992).

Improving school learning environment. According to the findings of this study, students tend to perform better in math if a good learning environment at school is provided. Principals and educators may enhance the math success of students through improving school learning environment. Canadian schools should particularly develop students' morale and disciplinary climate in order to raise average math achievement. Besides students' morale and disciplinary climate, students' behaviors hindering learning

(such as absenteeism, bullying other students, and so on) is an important factor which should be paid attention to for schools in Hong Kong-China. Moreover, the effects of school learning environment on school math achievement are stronger in Hong Kong-China than Canada, therefore more improvement may be expected in Hong Kong-China by advancing school learning environment.

Significance

This study will help to better understand the relationships among students' math achievement, students' beliefs about themselves in mathematics, and school characteristics about the learning environment in Canada and Hong Kong-China through using HLM. The differences in the HLMs of the two countries may be the reflection of the two various educational systems and cultural values.

For researchers, this study raises two problems in this area: (1) the previous research to a large extent ignored the impact of environment on the relationships between students' self-beliefs in math and their mathematics achievement; (2) few cross-cultural studies were conducted on children's perceptions about themselves as associated with school achievement. More studies are necessary to fill these gaps. For governments and schools, the findings of this research will help to make policy decisions, which in turn, might improve students' academic achievement and the whole educational systems.

Limitations

Some of this study's limitations are noted as below. The corresponding suggestions are also provided.

First, HLM per se has its limitations. Although significant relationships are observed in this study, HLM does not reveal their causality. More causal modeling and more experimental studies are needed in order to explore the causal relationships, which may provide clearer directions for improving students' math achievement. Furthermore, linear relationships were modeled in this study.

Second, students' math achievement is determined by many factors. Modeling only students' self-beliefs in math and school learning environment is unlikely to explain all the variance of math scores. Students' self-beliefs in math at the student level and learning environment at the school level only account for a small portion of the variation of math scores. A greater variety of variables can be considered in the HLMs, resulting in a better understanding of students' math performance and more accounted variance of math scores.

Third, this study compares the average self-efficacy slopes, the average self-concept slopes, and the school-level coefficients between Canada and Hong Kong-China in the HLMs. These comparisons can only tell the differences, but not the significance of those differences. For example, the average self-concept slope in Canada is 19.12, which means that one unit (about one standard deviation) increase in Math Self-concept is associated with 19.12 points higher in math scores on average given that other variables are fixed. The average self-concept slope in Hong Kong-China is 13.89, which indicates that one unit (about one standard deviation) increase in Math Self-concept is associated with 13.89 points higher in math scores on average if other variables are held constant.

Consequently, the relationship between math self-concept and math scores is generally stronger in Canada than in Hong Kong-China, but is this difference ($19.12 - 13.89 = 5.23$) statistically significant or practically significant? This study does not test this.

Suggestions for Future Research

First, this research does not take the gender effect into account. Many studies indicate that boys tend to have significantly more positive math self-efficacy than girls although they do not necessarily perform better in math than girls (Campbell & Hackett, 1986; Hackett & Betz, 1982). Hackett (1981) found that gender impacts mathematics self-efficacy indirectly through socialization influences and mathematics preparation. However, few researchers examined the gender differences in relationships among self-beliefs, learning environment, and academic achievement, in different societies and under various cultural backgrounds. Future research may add gender to models.

Second, the present research only studies the students aged between 15 years 3 months and 16 years 2 months. Students at various age levels should also be looked at due to the possibility of different findings. This study could be replicated with students at different ages to see whether there is any tendency in the relationships among self-beliefs, learning environment, and academic achievement, across ages.

Third, Bandura (1986) argued that successful functioning is best served by reasonable accurate efficacy appraisals, and some overestimation of capability is helpful since it increases students' effort and persistence. However, researchers know little about how much overconfidence may be considered as excessive and maladaptive (Pajares &

Kranzler, 1995). It may be more reasonable to help students develop more accurate self-beliefs rather than just raise already overconfident beliefs. More studies are suggested to explore the nature of overconfidence and how to help students develop their appropriate self-beliefs without letting them lose confidence.

Fourth, Bandura (1993) stated that self-efficacy predicts students' motivational orientation. Students with more positive self-efficacy also tend to have greater intrinsic motivation. Therefore, Canadian students may have greater intrinsic motivation than Hong Kong-Chinese students, while Hong Kong-Chinese students may have greater extrinsic motivation due to the pressure from parents, teachers, and peers, competitions in schools and the society, and other external forces. Although intrinsic motivation is believed more advantageous than extrinsic motivation in educational setting (Stipek, 1992), students in Hong Kong-China outperformed students in Canada. Future research is recommended to examine the effects of intrinsic motivation and extrinsic motivation on students' academic performance in different countries.

Fifth, in the PISA 2003, the data on school learning environment (including teacher support, disciplinary climate, students' and teachers' behaviors, students' and teachers' morale and commitment) are either based on students' or principals' perceptions. It may be a good idea to hear the voice from both sides on the same questions since students and principals probably perceive and think in different ways. In the future, PISA could include the same items regarding school learning environment both in the student questionnaire and the school questionnaire in order to do comparisons between students'

and principals' perceptions, and to make research findings more accurate.

Sixth, some suggestions are provided for improving the questionnaires in the PISA 2003. There is no option to indicate neutral opinions in the questionnaires. The addition of "I don't know" or "I am not sure" may increase the accuracy of the measures.

Qualitative studies are encouraged to complement the original questionnaires. It is useful to know how students develop their self-beliefs, how they feel the self-beliefs influence their learning, and so on. Therefore, some open-ended questions are suggested to be included in the questionnaires. Furthermore, for the questions assessing math self-concept, math self-efficacy, teacher support, disciplinary climate, and students' and teachers' morale, the answer options are listed from the most positive on the left side to the most negative on the right side, while the answer options for the questions measuring student's and teacher's behaviors are listed in an opposite order. This inconsistency may lead to respondents' confusion and response mistakes. The answer choices for all the questions are recommended to align from the most negative on the left side to the most positive on the right side, which is the generally recognized layout in most questionnaires.

Furthermore, other measurement instruments used in earlier research, as mentioned in the review of the literature, can be regarded as references and provide additional appropriate items for the PISA questionnaires to increase the reliability.

Consequently, many problems and questions are still less known. Improvement and better understanding can be achieved through the efforts in the future.

Conclusion

The primary aim of this study is to examine and compare the relationships among students' beliefs about themselves in mathematics, learning environment at school, and math achievement, at student and school levels, in Canada and Hong Kong-China. Similarities and differences between the two countries exist.

There are three research questions in this study. According to the research findings, the answers of the three questions are demonstrated as below:

(1) At the student level, what are the relationships between students' beliefs about themselves in math (math self-concept and self-efficacy) and their math achievement in Canada and Hong Kong-China respectively?

In Canada and Hong Kong-China, math self-concept and math self-efficacy are significantly and positively related to math achievement. Students who have higher math self-efficacy and math self-concept are predicted to perform better in math than students who have lower math self-efficacy and math self-concept.

In Canada, as the value of Math Self-efficacy increases by one unit (about one standard deviation), the students tend to have 29.73 points higher on the math assessment on average when other variables are constant. One unit (about one standard deviation) increase in Math Self-concept associates with 19.12 points higher in math scores on average given that other variables are fixed.

In Hong Kong-China, as the value of Math Self-efficacy increases by one unit (about one standard deviation), the students tend to have 27.74 points higher on the math

assessment on average when other variables are constant. One unit (about one standard deviation) increase in Math Self-concept associates with 13.89 points higher in math scores on average given that other variables are fixed.

(2) At the school level, how does the learning environment at school (teacher support, the disciplinary climate in mathematics lessons, students' and teachers' behaviors affecting the school climate, teachers' and students' morale and commitment) affect mean math achievement across schools and moderate the relationships between students' beliefs about themselves in math and their math achievement in Canada and Hong Kong-China separately?

In Canada, students' morale and disciplinary climate are positively associated with average school scores, while teacher support is negatively related to average school scores. There is significant school variation in average school scores after controlling students' morale, disciplinary climate, and teacher support. The self-efficacy slopes and self-concept slopes both significantly vary across schools although there are no significant school correlates.

In Hong Kong-China, students' morale, students' behaviors, and the disciplinary climate are positively associated with average school scores, while teacher support is negatively related to average school scores. There is significant school variation in average school scores after controlling students' morale, students' behaviors, teacher support, and the disciplinary climate. Raising students' morale weakens the relationship between math self-efficacy and math achievement. The self-efficacy slopes are not

significantly different from school to school after controlling students' morale. Increasing teachers' morale enhances the relationship between math self-concept and math achievement. There is no significant school variation in self-concept slopes after conditioning teachers' morale.

(3) What are the differences between Canada and Hong Kong-China in those relationships?

In sum, it is found that Canada has stronger relationships between students' self-beliefs in math and their math performance than Hong Kong-China. School learning environment, as measured by teacher support, disciplinary climate, students' and teachers' behaviors, and students' and teachers' morale, has more effect on school math achievement in Hong Kong-China than in Canada. School variations of self-efficacy slopes and self-concept slopes are accountable by school learning environment in Hong Kong-China, but not in Canada.

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Appendix A

PISA 2003 Questionnaire Items

For judging the students' mathematics self-concept, there are five statements.

Q 32. Thinking about studying mathematics: To what extent do you agree with the following statements?

SA=Strongly agree, A=agree, D=disagree, SD=strongly disagree

		SA	A	D	SD
ST32Q02	b) I am just not good at mathematics.				
ST32Q04	d) I get good marks in mathematics.				
ST32Q06	f) I learn mathematics quickly.				
ST32Q07	g) I have always believed that mathematics is one of my best subjects.				
ST32Q09	j) In my mathematics class, I understand even the most difficult work.				

For measuring the students' mathematics self-efficacy, there are eight statements.

Q31. How confident do you feel about having to do the following calculations?

VC=very confident, C=confident, NVC=not very confident, NAAC=not at all confident.

		VC	C	NVC	NAAC
ST31Q01	a) Using a train timetable to work out how long it would take to get from one place to another.				
ST31Q02	b) Calculating how much cheaper a TV would be after a 30% discount.				
ST31Q03	c) Calculating how many square meters of tiles you need to cover a floor.				
ST31Q04	d) Understanding graphs presented in newspapers.				
ST31Q05	e) Solving an equation like $3x+5=17$.				
ST31Q06	f) Finding the actual distance between two places on a map with a 1:10,000 scale.				
ST31Q07	g) Solving an equation like $2(x+3)=(x+3)(x-3)$.				
ST31Q08	h) Calculating the petrol consumption rate of a car.				

As to the teacher support in mathematics, students are asked their opinions on the five statements:

Q38. How often do these things happen in your mathematics lessons?

EL=every lesson, ML=most lessons, SL=some lessons, N=Never or hardly ever

		EL	ML	SL	N
ST38Q01	a) The teacher shows an interest in every student's learning.				
ST38Q03	c) The teacher gives extra help when students need it.				
ST38Q05	e) The teacher helps students with their learning.				
ST38Q07	g) The teacher continues teaching until the students understand.				
ST38Q10	j) The teacher gives students an opportunity to express opinions.				

Students' views on the disciplinary climate in their mathematics lessons

Q38. How often do these things happen in your mathematics lessons?

EL=every lesson, ML=most lessons, SL=some lessons, N=Never or hardly ever

		EL	ML	SL	N
ST38Q02	b) Students don't listen to what the teacher says.				
ST38Q06	f) There is noise and disorder.				
ST38Q08	h) The teacher has to wait a long time for students to quieten down				
ST38Q09	i) Student cannot work well.				
ST38Q11	k) Students don't start working for a long time after the lesson begins.				

Principals' perceptions about student-related factors affecting the school climate

Q25 In your school, to what extent is the learning of students hindered by:

NAA=not at all, VL=very little, TSE=to some extent, AL=a lot

		NAA	VL	TSE	AL
SC25Q02	b) Students absenteeism				
SC25Q04	d) Disruption of classes by students.				
SC25Q07	g) Students skipping classes				
SC25Q08	h) Students lacking respect for teachers				
SC25Q10	j) Student use of alcohol or illegal drugs.				
SC25Q12	l) Students intimidating or bullying other students.				

Principals' perceptions about teacher-related factors affecting the general school climate
 Q25 In your school, to what extent is the learning of students hindered by:
 NAA=not at all, VL=very little, TSE=to some extent, AL=a lot

		NAA	VL	TSE	AL
SC25Q01	a) Teachers' low expectations of students.				
SC25Q03	c) Poor student-teacher relations.				
SC25Q05	e) Teachers not meeting individual students' need.				
SC25Q06	f) Teacher absenteeism.				
SC25Q09	i) Staff resisting change.				
SC25Q11	k) Teachers being too strict with students.				
SC25Q13	m) Students not being encouraged to achieve their full potential.				

Teachers' views on their morale and commitment

Q24 Think about the teachers in your school. How much do you agree with the following statements?

SA=strongly agree, A=agree, D=disagree, SD=strongly disagree

		SA	A	D	SD
SC24Q01	a) The morale of teachers in this school is high.				
SC24Q02	b) Teachers work with enthusiasm.				
SC24Q03	c) Teachers take pride in this school.				
SC24Q04	d) Teachers value academic achievement.				

Teachers' views on students' morale and commitment

Q11 Think about the students in your school. How much do you agree with the following statements?

SA=strongly agree, A=agree, D=disagree, SD=strongly disagree

		SA	A	D	SD
SC11Q01	a) Students enjoy being in school.				
SC11Q02	b) Students work with enthusiasm.				
SC11Q03	c) Students take pride in this school.				
SC11Q04	d) Students value academic achievement.				
SC11Q05	e) Students are co-operative and respectful.				
SC11Q06	f) Students value the education they can receive in this school.				
SC11Q07	g) Students do their best to learn as much as possible.				