Chapter Three

Research Method

Based on the literature review, the purpose of the present research is to find out the relationship among self-concept, self-efficacy and achievement in mathematics. This chapter is divided into four sections and each section will be introduced in detail. They are research structure, data source and sample, research constructs, and statistical analysis.

3.1 Research Structure

According to the hypotheses for the present research, mathematics self-efficacy, mathematics self-concept, and mathematics achievement are the three constructs as shown in figure 3.1-1.

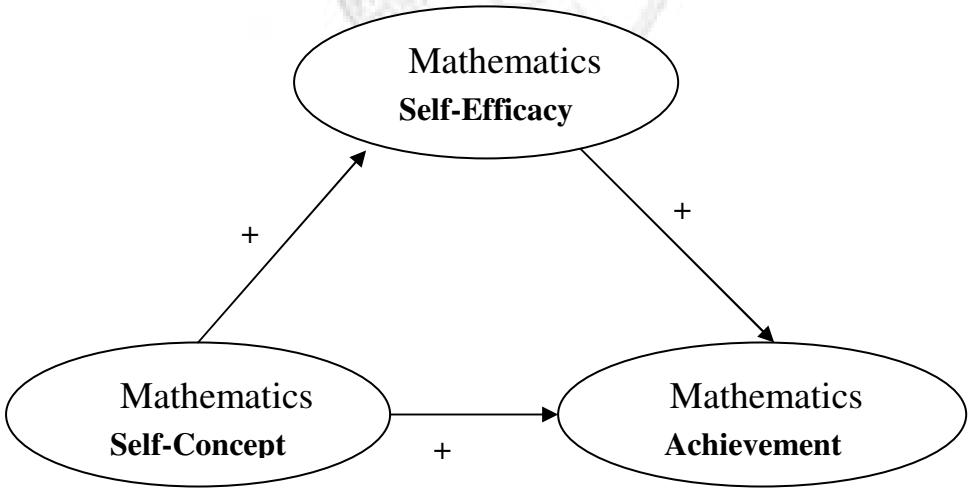

Figure 3.1-1 The research framework

3.2 Data Source and Sample

The present research was based on the PISA database initiated by the OECD, which consists of representative responses by 15-year-old students in forty-one countries in year 2003. This database included a direct assessment of students' skills, a student questionnaire, and a school questionnaire completed by principals. Moreover, PISA is based on the strong quality assurance mechanisms for translation, sampling and data collection (OECD, 2005). The database was collected in response to the need for internationally comparable evidence of student performance and the measure was made on the basis of advice from experts. For all these high quality measures, it makes PISA with superior levels of validity and reliability in order to improve the understanding of education systems and students' characteristics. Paper-and-pencil tests are used and two hours is required for each student to complete this assessment. A mixture of multiple-choice items and questions that required students to construct their own responses in the test. The focus of PISA 2003 is on mathematical literacy which consists of quantity, space and shape, change and relationships, and uncertainty. In total, 85 mathematics problems were used.

Since Taiwan joined this assessment in 2006 and the data is not released yet until 2007, the researcher chose to analyze samples in Hong Kong, which had similar culture and language to Taiwan's, as for example. The present investigation was based on students who had mathematics achievement test scores and who completed the questionnaire items of mathematics self-concept and mathematics self-efficacy. Measures include five measures of mathematics self-concept and eight measures of

mathematics self-efficacy. Two-stage stratified sample was used for data collection in PISA 2003 and data was weighted to obtain unbiased estimates of population parameters. After listwise deletion for missing data and the deletion of outliers, 4402 students were selected, which include 2181 boys and 2221 girls. The effective sample was randomly divided into two groups, Group 1 includes 2191 students (1082 girls) and Group 2 includes 2211 students (1086 girls). Group 2 was used to verify with the new measurement models.

3.3 Research Constructs

The PISA 2003 context questionnaires included numerous items on student perceptions. According to the meaning of the constructs in PISA 2003, the current research chose mathematics self-efficacy, mathematics self-concept, and mathematics achievement as measuring constructs.

1. Mathematics self-concept

PISA 2003 defined mathematics self-concept as individuals' knowledge and perceptions about themselves in learning mathematics (OECD, 2005). Five items were used in measuring self-concept. They were rated on a four-point Likert scale. The four-point scale with the response categories "strongly agree", "agree", "disagree", and "strongly disagree" are used. One item was negatively phrased and not inverted for scaling. All other items were inverted for scaling so that positive scores indicate a positive self-concept in mathematics. Items are shown in Table 3.3-1.

Table 3.3-1 Items for mathematics self-concept

How much do you disagree or agree with the following statements about how you feel when studying mathematics?		
Variables in the present study	Variables in PISA	
X_1	ST32Q02	b) I am just not good at mathematics.
X_2	ST32Q04	d) I get good <marks> in mathematics.
X_3	ST32Q06	f) I learn mathematics quickly.
X_4	ST32Q07	g) I have always believed that mathematics is one of my best subjects.
X_5	ST32Q09	i) In my mathematics class, I understand even the most difficult work.

2. Mathematics self-efficacy

In PISA 2003, mathematics self-efficacy is defined as mathematics confidence. Eight items are used to measure students' confidence in mathematical task and positive scores on the index indicate higher levels of self-efficacy and vice versa. They were rated on a four-point Likert scale. The four-point scale with the response categories "strongly agree", "agree", "disagree", and "strongly disagree" are used. Items are shown in Table 3.3-2.

Table 3.3-2 Items for mathematics self-efficacy

How confident do you feel about having to do the following calculations?		
Variables in the present study	Variables in PISA	
Y_1	ST31Q01	a) Using a <train timetable>, how long it would take to get from Zedville to Zedtown.
Y_2	ST31Q02	b) Calculating how much cheaper a TV would be after a 30 percent discount.
Y_3	ST31Q03	c) Calculating how many square meters of tiles you need to cover a floor.
Y_4	ST31Q04	d) Understanding graphs presented in newspaper.
Y_5	ST31Q05	e) Solving an equation like $3x + 5 = 17$
Y_6	ST31Q06	f) Finding the actual distance between two places on a map with a 1:10,000 scale
Y_7	ST31Q07	g) Solving an equation like $2(x+3) = (x+3)(x-3)$
Y_8	ST31Q08	h) Calculating the petrol consumption rate of a car

3. Mathematics achievement

In PISA 2003, students' performance in mathematics is defined as mathematics literacy. One's capacity to identify and understand the role of mathematics, to make good use and engage in mathematics in ways that meet their needs of life. The mathematical content includes quantity, space and shape, change and relationships and uncertainty. Item response theory was used to produce five plausible values which indicate mathematics ability. These five plausible values randomly picked from the posterior distributions and should not be used for individual estimation. This research used plausible value 1 as mathematics achievement. Mathematics achievement is variable Y_9 in the present study.

3.4 Statistical Analysis

All analyses were conducted with SPSS 11.5 for Windows and LISERAL 8.72 as following:

1. Internal consistency (Cronbach's alpha)

   Cronbach's alpha was conducted with SPSS 11.5 and it varies from 0 to 1.0. The indicators should have a Cronbach's alpha of .7 to judge the set reliable (Hair, Anderson, Tatham, & Black, 1998). It is possible that a set of items will be below .7 on Cronbach's alpha. Alpha may be low because of lack of homogeneity of variances among items, for instance, and it is also lower when there are fewer items in the scale/factor (Miller, 1995). Cronbach's alpha is used to test the internal consistency of mathematics self-concept and mathematics self-efficacy the in present study.

2. Boxplot

   Boxplot was conducted with SPSS 11.5. The result of a boxplot analysis can indicate that the observations, if any, are considered unusual, or outliers.

3. Confirmatory factor analysis (CFA)

   CFA is used to confirm that the items sort themselves into the specific factors, as previously determined by theories. The present research used confirmatory factor analysis to examine the Hypothesis 1 that all items of self-concept and self-efficacy are good measures in the database of Hong Kong.

4. Structural equation models (SEMs)

SEMs were conducted with LISREL 8.72. The model is tested using SEM goodness-of-fit tests to determine if the pattern of variance and covariance in the data is consistent with a structural model that is specified. The present research used structural equation models to examine the relationships among mathematics self-concept, mathematics self-efficacy and achievement which is Hypothesis 2.