# ADOLESCENTS' PERCEPTION OF PARENTAL AND PEER MATHEMATICS ANXIETY AND ATTITUDE TOWARD MATHEMATICS: A COMPARATIVE STUDY OF EUROPEAN-AMERICAN AND MAINLAND-CHINESE STUDENTS

By

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To the Faculty of Washington State University:

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Chair

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Abstract

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The primary purpose of this study was to examine the similarities and differences in adolescents' perception of their parents', peers' and their own mathematics anxiety and attitudes toward mathematics between European-American and Mainland-Chinese groups. The second goal of this study was to examine whether adolescents' perception of their parents', peers' and their own mathematics anxiety and attitudes toward mathematics predict their perceptions of mathematics achievement in both European-American and Mainland-Chinese groups. The samples of this study were 80 Mainland-Chinese and 54 European-American adolescents. Students were evaluated with the Math anxiety Rating-Scale-Revised (MARS-R) and The Attitudes toward Mathematics Inventory (ATMI). European-American adolescents (*M* = 37.463, *SEM* = 1.145) view their peers as more anxious than Mainland-Chinese adolescents (*M* = 33.381, *SEM* = .945). Mainland-Chinese adolescents (*M* = 37.518, *SEM* = .697) view their peers as holding more positive attitudes toward mathematics than European-American adolescents (*M* = 30.944, *SEM* = .844). European-American adolescents' perceptions of parental and peers' math anxiety predicted their perceptions of own math anxiety ($F$ (2, 51) = 9.545, $p < .01$). European-

American adolescents' perceptions of mathematics anxiety negatively predicted adolescents' perceptions of their own mathematics achievement and their perceptions of math attitudes positively predicted their perceptions of their own math achievement ($F$ (2, 51) = 6.359, $p < .01$). For Mainland-Chinese adolescents, (a) their perception of peers' anxiety significantly predicted their own anxiety ($F$ (2,77) = 23.060, $p < .01$); (b) their perceptions of parents' and peers' mathematics attitudes significantly predicted their own mathematics attitudes ($F$ (2, 77) = 20.63, $p < .01$); (c) their perception of their parents' anxiety negatively predicted adolescents' mathematics achievement ($F$ (2, 77) = 3.614, $p = .032$); (d) their perception of their peers' anxiety negatively predict adolescents' mathematics achievement ($F$ (2, 77) = 3.884, $p = .025$); and (e) adolescents' mathematics anxiety and math attitudes significantly predict their math achievement ($F$ (2, 77) = 15.592, $p < .001$). Findings from this study support the notion that parents' and peers' math anxiety and attitudes toward mathematics provide an important source for adolescents' math anxiety, attitudes and math achievement.

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# CHAPTER ONE

# INTRODUCTION

## Needs for the study

Many researchers have sought to identify students' in and out of school experiences that influence achievement and related outcomes (Reynolds & Walberg, 1992). Cross-cultural comparative studies continue to find the poor performance of U.S. students in mathematics and science, particularly in junior and senior high school. Large-scale surveys of the International Association for the Evaluation of Education Achievement (McKnight et al., 1987) and the International Assessment of Educational Progress (Dossey, Mullis, Lindquist, & Chambers, 1988; Lapointe, Mead, & Phillips, 1989; Olson, 1990) confirm poor U.S. performances and have suggested both cognitive and affective causes, such as quality of instruction, motivation, peer group, students' attitudes toward mathematics, mathematics anxiety and students' prior achievement.

A number of researchers have investigated the relationship between the affective and the cognitive domains. Maker (1982) emphasized the importance of this relationship:

> It is impossible to separate the cognitive from the affective domains in any activity .... The most important is that there is a cognitive component to every affective objective and an affective component to every cognitive objective. (p. 30-31)

Current efforts in reforming mathematics curriculum and instruction have placed a special emphasis on this relationship. For example, the National Council of Teachers of Mathematics (1989) and the National Research Council (1989) have encouraged mathematics educators to incorporate affective factors with cognitive factors in mathematics teaching and learning.

*Attitudes toward Mathematics*

In general, attitudes, beliefs, and emotions are the major descriptors of the affective domain in mathematics education (McLeod, 1992), whereas knowledge and thinking are considered descriptors of the content and process of the human mind (Brown & Borko, 1992). Rather than attempt to explore all the components in the affective domain as they relate to the cognitive domain, mathematics educators have traditionally taken the relationship between attitude toward mathematics and achievement in mathematics as their major concern. For example, according to a meta-analysis assessing the relationship between attitude toward mathematics and achievement in mathematics, there were 108 studies examining the general relationships between attitude and achievement with overall weighted mean effect size of .12, indicating that the relationship between attitude and achievement was positive and reliable, but not strong (Ma & Kishor, 1997).

Approximately 10 studies exist examining the causal relationship between attitude toward mathematics and achievement in mathematics (Ma & Kishor, 1997). The overall weighted mean effect size is .08, indicating that the effect of attitude toward mathematics on math achievement cannot be described as practically meaningful. Also, the achievement (cause) – attitude (effect) relationship was not statistically significant, indicating that the effect of attitude on achievement was not much different from zero. In addition, student's gender did not have a significant effect on the relationship, indicating that the relationship between attitude toward mathematics and mathematics achievement was quite similar for male and female students.

Studies examining the effect of grade on the relationship between attitude and achievement illustrated that statistically, the attitude-achievement relationship was significant at both elementary and secondary school (Ma & Kishor, 1997). However, weighted mean effect size suggested that the relationship between attitude and achievement might not be important at elementary school level, but might be practically meaningful at the secondary school level. Moreover, the relationship between attitude and achievement did not seem important for White students (Ma & Kishor, 1997). Only for Asian students was there evidence that positive attitudes strongly correlated with high achievement. Black students also demonstrated a practically important relationship between attitude and achievement.

*Mathematics Anxiety*

In recent years, there has been an increasing recognition that mathematics anxiety plays a critical role in students' learning of mathematics. Aiken (1960) considered mathematics anxiety a "relative" of the general attitude toward mathematics, only being more visceral. However, most researchers considered mathematics anxiety to be a construct that was distinct from attitude toward mathematics. For example, McLeod (1992) stated that the term attitude "does not seem adequate to describe some of the more intense feelings that students exhibit in mathematics classrooms" (p. 576), such as anxiety, confidence, frustration, and satisfaction. Mathematics anxiety is often refereed to as "the general lack of comfort that someone might experience when required to perform mathematically" (Woood, 1988, p. 11) or the feeling of tension, helplessness, and mental disorganization one has when required to manipulate numbers and shapes (Richardson & Suinn, 1972; Tobias, 1978). Mathematics anxiety can take multidimensional forms including, for example, dislike (an attitudinal element), worry (a cognitive element), and fear (an emotional element) (Wigfield & Meece, 1988).

Although the search for causes of mathematics anxiety is often unsuccessful (Gough, 1954), many researchers have reported the consequences of being anxious toward mathematics, including the inability to do mathematics, the decline in mathematics achievement, the avoidance of mathematics courses, the limitation in selecting college majors and future careers, and the negative feelings of guilt and shame (Armstrong, 1985; Betz, 1978; Brush, 1978; Burton, 1979; Donady & Tobias, 1977; Hendel, 1980; Preston, 1986; Richardson & suinn, 1972; Tobias & Weissbrod, 1980). Therefore, not only are the professional and economic gains that would result from changing mathematics anxiety into mathematics confidence, indispensable, the psychological boost that individuals experience when they are successful in mathematics is also important (National Research Council, 1989).

Most researchers started with the linear notion that anxiety could seriously impair performance (Lazarus, 1974). Specifically, a higher level of anxiety was associated with a lower level of achievement. This negative relationship has been displayed across several age populations. For example, mathematics anxiety was negatively correlated with mathematics performance among adults in general (Quilter & Harper, 1988) and among college students in particular (Betz, 1978; Frary & Ling, 1983). This negative relationship also appeared at the elementary and secondary school levels (Chiu & Henry, 1990; Lee, 1991; Meece, Wigfield, & Eccles, 1990). Hembree (1990) reported an average correlation of -.34 for school students, concluding that mathematics anxiety could seriously constrain performance in mathematics tasks and that reduction in anxiety was consistently associated with improvement in achievement.

Some researchers have attempted to introduce mediating variables, such as gender, grade and ethnicity, into the theoretical model of relationship. For example, Eccles and Jacobs (1986) suggested that gender differences in mathematics anxiety are attributable to gender differences in mathematics achievement. Hembree (1990) found that mathematics anxiety could increase during junior high grades, reaches its peak in Grades 9 and 10, and levels off during senior high grades, implying that the relationship is a function of grade levels. Engelhard (1990) showed that the correlation between mathematics anxiety and mathematics achievement was higher among American students than among Thai students, indicating that the same level of anxiety tends to be associated with achievement of American students more strongly than with achievement of Thai students. McLeod (1992) concluded that "it seems reasonable to hypothesize that affective factors are particularly important to differences in performance between groups that come from different cultural backgrounds" (p. 587).

*Parents' and Peers' Influence*

A large body of literature has focused on identifying parents' influences on adolescents' achievement and achievement-related beliefs and attitudes (Stevenson, Lee, et al., 1990). For example, Eccles (1993) proposed a model illustrating the possible contribution of parental beliefs, attitudes, and practices on adolescents' outcomes. His theoretical model includes five interrelated areas of influences: (a) parents, family and neighborhood characteristics; (b) the child's own characteristics; (c) parents' general attitudes and beliefs; (d) parents' child-specific beliefs, such as expectations and perceptions on child's ability; and (e) parents' practices. Specifically, this study will focus on parents' attitudes toward mathematics and examine whether their families' general cultural traditions will have implication.

In the last few years educational researchers have become increasingly aware of the need to examine interaction among students to understand the impact of peer groups on learning. For example, Webb (1985) found that in general a student's giving and receiving help within the group had no effect on the students' achievement. However, the kind of help that was given or received did affect achievement. Some researchers have conducted experiments to investigate how adolescents' self-efficacy and achievement were influenced by their peer model observation (Schunk & Hanson, 1985). They found that observing a successful peer model led to higher self-efficacy for learning, posttest self-efficacy, and achievement than did observing the teacher model or not observing a model. But almost no attention has been given to examine the impact of peers' influences on adolescents' mathematics anxiety and attitudes toward mathematics.

*Ethnicity Difference in Mathematics Achievement*

A primary concern of the American educational system today is that of raising the mathematics levels of its students. However, cross-national studies demonstrate the pervasiveness of poor mathematics performance among American school children relative to that of Chinese, Japanese, and Korean children (Hess, Chang, & McDevitt, 1987; Stevenson, et al., 1990; Stevenson, Lee, Chen, Stigler, Hsu, & Kitamura, 1990). Because these differences were evident as early as kindergarten, it appears that cultural and family factors contributed significantly to the difference. Moreover, in the United States, Asian-American children outperformed other American children in mathematics domain, even though they were educated in the same school systems (Caplan, Choy, & Whitmore, 1992). Again, parenting and family factors were implicated. Researchers have indicated several reasons why American students cannot perform as well as Asian students, such as motivation style, curriculum differences, parental involvement, time use, and adolescents' attitudes about how well they were doing in mathematics and how easy mathematics was for them (Chao, 1994). Particularly, traditional Chinese views of teaching and parenting contribute to students' academic success (Ho, 1994). However, almost no attention has been given to examining the ethnic difference in adolescents' mathematics anxiety and attitudes toward mathematics between Mainland China and European America.

## Purpose of Study

The primary purpose of this study was to examine the similarities and differences in adolescents' perception of their parents', peers' and their own mathematics anxiety and attitudes toward mathematics between European-American and Mainland-Chinese groups. The second goal of this study was to examine whether adolescents' perception of their parents', peers' and their own mathematics anxiety and attitudes toward mathematics would predict their perceptions of their own mathematics achievement in both European-American and Mainland-Chinese groups (see Figure 1).

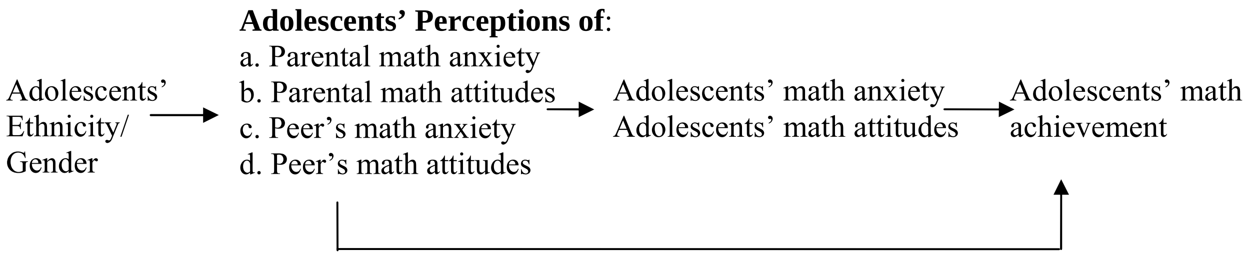


*Figure 1.* Purpose of study

## Null Hypotheses

*Perceptions of Parents*

1. No difference exists by ethnicity, gender or by interaction between ethnicity and gender on European-American and Mainland-Chinese adolescents' perceptions of parental math anxiety and math attitudes.

*Perceptions of Peers*

2. No difference exists by ethnicity, gender or by interaction between ethnicity and gender on European-American and Mainland-Chinese adolescents' perceptions of their peers' math

anxiety and math attitudes.

*Perception of Students*

3. No difference exists by ethnicity, gender or by interaction between ethnicity and gender on European-American and Mainland-Chinese adolescents' perceptions of math anxiety and math attitudes.

*Additional research questions:*

1. How do Mainland-Chinese adolescents' perceptions of their parents' and peer' math anxiety predict their perceptions of their own math anxiety?
2. How do European-American adolescents' perceptions of their parents' and peer' math anxiety predict their perceptions of their own math anxiety?
3. How do Mainland-Chinese adolescents' perceptions of their parents' and peer' math attitudes predict their perceptions of their own math attitudes?
4. How do European-American adolescents' perceptions of their parents' and peer' math attitudes predict their perceptions of their own math attitudes?
5. How do Mainland-Chinese adolescents' perceptions of their parents', peers' and their own math anxiety and math attitudes predict their perceptions of their own mathematics achievement?
6. How do European-American adolescents' perceptions of their parents', peers' and their own math anxiety and math attitudes predict their perceptions of their own mathematics achievement?

## Assumptions

1. Math anxiety Rating-Scale-Revised (MARS-R) and The Attitudes toward Mathematics Inventory (ATMI) are valid and reliable. The instruments are reliable and valid for both European-American and Mainland-Chinese high school students.
2. High school students have a comprehension ability to read and accurately answer the questions.
3. The translated Chinese version of the MARS-R and ATMI are valid.
4. Students participating in this study will provide an honest effort in answering those instruments.
5. The researcher who will collect data in America and China will conduct the data collection following the procedures.

## Delimitation

1. This study was delimited to high school adolescents in both European America and Mainland China.
2. This study was delimited to high school adolescents in one Northwest high school in U.S. and one Southwest high school in Mainland China.

## Terms

**Attitude**: a learned predisposition or tendency on the part of an individual to respond positively or negatively to some object, situation, concept, or another person.

**Attitude toward mathematics**: an aggregated measure of a liking or disliking of mathematics, a tendency to engage in or avoid mathematics activities, a belief that one is good or bad at mathematics, and a belief that mathematics is useful or useless.

**Math anxiety:** feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations.

**Self-efficacy expectation:** a person's beliefs concerning his or her ability to successfully perform a given task or behavior, are a major determinant of whether a person will attempt a given task, how much effort will be expended, and how much persistence will be displayed in pursuing the task in the face of obstacles.

## Significance

There may be several contributions of this study. First, ethnic differences in parents' and peers' mathematics anxiety and attitudes toward mathematics between European-American families and Mainland-Chinese families will be expected. From a theoretical perspective, the findings will be consistent with previous studies confirming that parental beliefs and attitudes could influence their adolescents' attitudes and performance. Generally speaking, Mainland-Chinese parents tend to encourage their children to work hard and spend more time studying while European-American parents believe if their children are smart enough, they do not have to work hard and they believe in inherent ability instead of hard work. These perspectives may explain why Mainland-Chinese adolescents perform better in mathematics than European-American adolescents.

Second, for both ethnic groups, adolescents' perceptions of their peers' mathematics anxiety and attitudes toward mathematics will predict students' own mathematics anxiety and attitudes. None of the previous studies examined adolescents' peers' impact in terms of mathematics anxiety and attitudes toward mathematics. This result can be added to the literature on mathematics anxiety and mathematics attitudes generally. In order to understand peers' influences more specifically, future research can examine how peers' interactions impact students' learning and what types of interaction can motivate students and improve students' achievement.

Third, this study may provide information about whether Chinese parents and adolescents believe mathematics is more important and valuable in their lives than American parents and adolescents. Few of previous studies discussed the relationships between the values of mathematics adolescents hold and their achievement. Especially for U.S. students, their lower mathematics achievement scores may not because of their high anxiety or parental involvement. The reason might be that they do not feel mathematics is valuable or important at all. Thus, these results can be added to literature that math anxiety may not be significant reason to explain why Mainland-Chinese adolescents have better math achievement than European-American adolescents.

Fourth, from a practical perspective, mathematics is important for an individuals' future career. It is important for both technology and social science. There are different ways to help adolescents having positive attitudes toward mathematics and having good experiences in learning mathematics. Findings from this study may help us understand how adolescents' parents' and peers' beliefs and attitudes may impact adolescents when learning math. In order to improve U.S. students' mathematics achievement, parents, teachers and researchers may learn from this study. For example, parents may provide a solid mathematics background for their children in early years and they can structure their child's time to a greater degree and involve more in mathematics-related activities. From a teacher's perspective, formal teaching techniques appear more effective than informal techniques in teaching mathematics, which may affect math anxiety and math attitudes. These results challenge the dominant early childhood philosophy in the United States (Huntsinger, Jose, Liaw, & Ching, 1997) which recommends non-directive discovery approaches to young children's mathematics, which may negatively affect math anxiety and math attitudes. From this study we may have a better understanding of parental and peers' influences on math anxiety and attitudes and thus better identify and focus research towards methods to help students gain value for meaningful and appropriate mathematics achievement.

# CHAPTER TWO

# LITERATURE REVIEW

A strong background in mathematics is critical for many career and job opportunities in today's increasingly technological society. However, certain features of math, such as its precision, logic, and emphasis on problem solving, make it particularly anxious for some individuals (Richardson & Woolfork, 1980). As early as 1957, Dreger and Aiken suspected that many individuals suffered from "number anxiety" and discovered that this newly created construct correlated with final mathematics grades. Since that time, mathematics anxiety has been the focus of numerous investigations (Betz, 1978; Richardson & Woolfolk, 1980; Wigfield & Meece, 1988).

Malmivuori (2001) indicated the learning process in school mathematics is a continuous interplay between affect and cognition, conditional on the characteristics of the social environment in which learning takes place. In particular, the interplay between mathematics anxiety and achievement has been the topic of many empirical studies. Therefore, the negative effects of math anxiety on students' achievement in mathematics have interested researchers for several years. In addition, researchers have found students' math attitudes or self-efficacy could be predictors of math anxiety, and students' perceptions of their parents' or peers' math anxiety and attitudes also may influence math anxiety of students (Betz, 1978; Wigfield & Meece, 1988; Wright & Miller, 1981).

## Mathematics Anxiety

Math anxiety could be defined as "feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations" (Richardson & Suinn, 1972, p. 551). It has been demonstrated that the physiological, cognitive, and behavioral consequences of math anxiety may impair life functioning (Hopko, McNeil, Zvolensky, & Eifert, 2001). For example, individuals with math anxiety exhibit physiological reactivity to numeric stimuli and have faulty beliefs and negative attitudes regarding their problem solving abilities (Ashcraft & Kirk, 2001; Richardson & Woolfolk, 1980). These individuals also may avoid environment and careers that require utilization of math skills, and will sacrifice accuracy for speed when performing numeric tasks (Ashcraft & Faust, 1994; Chipman, Krantz & Silver, 1992). Other symptoms of math anxiety can include nausea, a hot tingling feeling, extreme nervousness, an inability to hear to the teacher, a tendency to become upset by noises, an inability to concentrate, negative self-talk, a stomach ache, and sweaty palms.

Spielberger (1972) conceptualized anxiety as a state, a trait, and a process. Through his model of anxiety-as-process, he explained anxiety as a result of a chain reaction that consisted of a stressor, a perception of threat, a state reaction, cognitive reappraisal, and coping. Cemen (1987) also defined mathematics anxiety as an anxious state in response to mathematics-related situations that are perceived as threatening to self-esteem. In her model of mathematics anxiety reaction, environmental antecedents, (such as negative mathematics experiences and lack of parental encouragement), dispositional antecedents (such as negative attitudes, lack of confidence), and situational antecedents (such as classroom factors, instructional format) are seen to impact to produce an anxious reaction with its physiological manifestations.

*Instruments Measuring Mathematics Anxiety*

Math anxiety has been assessed with various instruments. Most prominent is the 98-item *Mathematics Anxiety Rating Scale* (MARS, Richardson & Suinn, 1972). Subjects respond to each possible anxiety-producing situation by using one to five scale. Test-retest reliability for the MARS has been reported as .85 (Tryon, 1980), and coefficient alpha reliability has been estimated to be .97 (Rounds & Hendel, 1980). However, the length of that instrument has often been a stumbling block in its use. As a consequence, researchers have turned to instruments with fewer items. Betz (1978) adapted the Anxiety subscale of the *Fennema-Sherman Mathematics Attitudes Scales* (Fennema & Sherman, 1976) and created the *Mathematics Anxiety Scale* (MAS) to assess mathematics anxiety in college students. The MAS consists of 10 items using a 5-point likert-type scale. Generally, the MAS has been found to have strong internal consistency and stability with Cronbach's alpha equals .72. Other instruments includes the 24-item Mathematics Anxiety Rating Scale-Revised (MARS-R, Plake & Parker, 1982), the 6-item Sandman Anxiety toward Mathematics Scale (Sandman, 1979), and the *Math Anxiety Questionnaire* (MAQ, Wigfield & Meece, 1988).

*Mathematics Anxiety and Test Anxiety*

According to the test anxiety theory, test anxiety could be distinguished by two components: worry and emotionality (Liebert & Morris, 1967). Worry is the cognitive component of anxiety, consisting of self-deprecatory thoughts about one's performance. Emotionality is the affective component of anxiety, including feelings of nervousness, tension, and unpleasant physiological reactions to testing situations. These two components are empirically distinct, through they are correlated. However, most measures of math anxiety focus on affective reactions to math. For example, Richardson and Suinn's (1972) MARS is designed to assess anxious reactions to using mathematics in ordinary life and academic situations.

*Different Aspects of Mathematics Anxiety*

Recently researchers identified different aspects of mathematics anxiety in older children and adolescents by using MARS (Wigfield & Meece, 1988). For example, Suinn et al. (1988) tested more than 1,100 students in Grades 4-6 with the MARS-E, a questionnaire they developed for use with older elementary school children. A factor analysis revealed two situational components of mathematics anxiety: mathematics test anxiety, as reflected in answers to questions about children's feelings during math tests, and mathematics performance adequacy anxiety, as reflected in answers to questions about solving math problems in situations other than testing.

Wigfield and Meece (1988) adapted the *Math Anxeity Questionnaire* (MAQ; Meece, 1981) to examine the different components of math anxiety in elementary and secondary school students. They found that different components of math anxiety can be distinguished and that they are similar in younger and older children in boys and girls. Factor analysis of MAQ suggested that one component primarily taps negative affective reactions to math, such as nervousness, fear, and discomfort. The other component primarily taps worries about doing well in mathematics. The findings are consistent with the test anxiety theories. The conceptual distinctiveness of these two components also can be seen in their relations with other math attitudes, beliefs and math performances. The negative affective reactions scale correlated more strongly and negatively than the worry scale to children's math ability perceptions and math performances. In contrast, scores on the worry scale related more strongly and positively to the actual effort that students say they put into math and to the importance that they attach to math.

In addition, Gierl and Bisanz (1995) created *Mathematics Anxiety Survey* (MAXS) to assess each student's self-rated level of nervousness to different situations involving mathematics in Grade 3 and Grade 6. Students were instructed to circle their level of nervousness on a 5-point scale from not at all nervous to very, very nervous. This instrument includes two types of items: mathematics test anxiety and mathematics problem-solving anxiety. Mathematics test anxiety can be defined as feelings of nervousness associated with past, present, and future mathematical testing situations. Each item contained the phrase math test. Mathematics problem-solving anxiety can be defined as feelings of nervousness associated with situations both in and out of school that require students to solve math problems and use the solutions in some way. Gierl and Bisanz found mean scores on the measures of mathematics test anxiety increased from Grade 3 to 6 relative to mean scores on the measures of mathematics problem-solving anxiety. These results confirmed that mathematics test anxiety and mathematics problem-solving anxiety show different patterns of change across grade and therefore are not identical. In particular, as children progress through school, they become relatively more anxious about mathematics testing than about using mathematics to solve problems in contexts other than testing.

Researchers also suggested that mathematics test anxiety is different from school test anxiety (Gierl & Bisanz, 1995). In order to distinguish mathematics test anxiety and school test anxiety, Gierl and Bisanz asked students to respond to items on two measures of test anxiety that were worded identically except that one referred to “math tests” and the other to “tests in school”. As expected, the two measures positively correlated with each other. However, they are not completely redundant. School test anxiety and math test anxiety account for different portions of the variance in mathematics achievement for both grades. Also, levels of mathematics test anxiety were lower than school test anxiety at both grades. Thus, mathematics test anxiety appears to be related to, but somewhat different from, school test anxiety.

*Mathematics Anxiety and Mathematics Ability*

Some researchers have found that math anxiety is very highly and negatively correlated with perceptions of math ability (Fennema & Sherman, 1976). However, Wigfield and Meece (1988) suggested that math anxiety should be conceptually distinguished from perceptions of math ability. In their study, the negative affective reactions scale of MAQ, in particular, attempted to use items that did not confound anxiety and perceptions of ability. Their results showed that the anxiety that students report represents more than a lack of confidence in math; rather, it also centers on negative affective reactions to math.

**Relations between math anxiety and math achievement**

In general, researchers have found that math anxiety correlates significantly with mathematics achievement (Pajares & Miller, 1994; Ramirez & Dockweiler, 1987; Wigfield & Meece, 1988). These studies have shown that math anxiety relates negatively to students' performance on standardized tests of mathematics achievement, grades in mathematics, plans to enroll in advanced high school mathematics courses, and selection of math-related college majors (Armstrong, 1985; Betz, 1978, Richardson & Woolfork, 1980; Sherman & Fennema, 1977; Wigfield & Meece, 1988). For example, Gierl and Bisanz (1995) surveyed students in grade 3 and 6 by using Mathematics Anxiety Survey and collected the results of an achievement test in mathematics from school records. They found that correlations between mathematics achievement and math anxiety were moderate and negative for both grades. Students' math anxiety accounted for a small but significant portion of the variability in mathematics achievement in Grade 3 and Grade 6. Moreover, mathematics problem-solving anxiety tended to account uniquely for more variance on achievement tests than did mathematics test anxiety.

In a meta-analysis of the relationship between anxiety toward mathematics and achievement in mathematics, Ma (1999) examined 26 studies on this relationship among elementary and secondary students. The common population correlation for the relationship is significant (-.27). A series of general linear models indicated that the relationship is consistent across gender groups, grade-level groups, ethnic groups and instruments measuring anxiety. However, the relationship differs significantly among instruments measuring achievement as well as among types of publication. Researchers using standardized achievement tests tend to report a relationship of significantly smaller magnitude than researchers using mathematics teachers' grades and researcher-made achievement tests. Published studies tend to indicate a significantly smaller magnitude of the relationship than unpublished studies. There are no significant interaction effects among key variables such as gender, grade, and ethnicity.

However, mathematics anxiety is usually associated with mathematics achievement individually but not necessarily collectively (Ma, 1999). For example, research had indicated that the relationships between math anxiety and math achievement may not be significant after controlling for previous math performance (Dew, Galassi, & Galassi, 1984). Even though the direct effects of math anxiety tend to be relatively small, it has been suggested that math anxiety may have a number of important indirect effects. For example, anxious individuals may avoid math classes, may be more likely to have negative attitudes about computers, and math-related activities such as statistics (Betz, 1978; Gressard & Loyd, 1976; Adams & Holcomb, 1986). Engelhard (1990) examined the effects of math anxiety on mathematics achievement after controlling for previous performance, mother's education and gender. Results indicated that math anxiety had a significant effect on mathematics achievement after controlling for the effects of previous math performance, mother's education, and gender. A significant inverse relationship between math anxiety and math achievement was evident. The effects on mathematics performance of gender, mother's education, and previous achievement were also statistically significant. The overall model accounted for approximately 66% of the variance in mathematics achievement.

*The Significance of Gender, Age and Ethnicity*

Students' gender, age, and ethnicity are usually considered as mediating variables in the theoretical model of the relationship between math anxiety and math achievement (Ma, 1999). For example, several researchers also have proposed that math anxiety contributes to observed gender differences in mathematics achievement and course enrollment patterns (Tobias & Weissbrod, 1980). Gender typically accounts for only a small proportion of the variance in students' responses on math anxiety measures (Betz, 1978; Galassi & Galassi, 1983; Meece, 1981). However, in studies of high school and college students, female students consistently report higher levels of math anxiety than do male students (Meece, Wigfield, & Eccles, 1990; Pajares & Millers, 1994; Wigfield & Meece, 1988). These differences are not consistently found in studies with middle school or elementary school students (Pajares & Millers, 1995). For example, Gierl and Bisanz (1995) found no evidence that boys and girls in grade 3 and 6 differ on measures of mathematics anxiety. Moreover, Wigfield and Meece reported that there were no differences in the structure of boys' and girls' responses to the math anxiety measures, which indicates that they were answering the items in similar ways. Thus, any pervasive gender differences in mathematics anxiety that emerge probably do so after the elementary and middle school years. In addition, researchers have suggested that math anxiety helps to explain gender differences in math performance, as well as in course enrollment and selection of academic majors.

**Attitudes Towards Mathematics**

Attitude can be defined as "a learned predisposition or tendency on the part of an individual to respond positively or negatively to some object, situation, concept, or another person" (Aiken, 1970, p. 551). McLeod (1992) added that the positive or negative feeling is of moderate intensity and reasonable stability. Neale (1969) defined attitude toward mathematics as an aggregated measure of "a liking or disliking of mathematics, a tendency to engage in or avoid mathematics activities, a belief that one is good or bad at mathematics, and a belief that mathematics is useful or useless" (p.623). In recent studies, researchers extended Neale's definition of attitude toward mathematics to include students' affective responses to the easy/difficult dimension as well as the importance/unimportance dimension of mathematics (Ma & Kishor, 1997).

In both theory and practice, a strong relationship between attitude toward mathematics and mathematics achievement has long been assumed. Suydam and Weaver (1975) illustrated:

> Teachers and other mathematics educators generally believe that children learn more effectively when they are interested in what they learn and when they will achieve better in mathematics if they like mathematics. Therefore, continual attention should directe towards creating, developing, maintaining and reinforcing positive attitudes. (p.45)

It is clear that knowledge about the importance of math is important, as reported in *The Longitudinal Study of American Youth* (1991), which showed that 28 percent of all seniors who were not enrolled in a mathematics or science course did not believe advanced mathematics was required for their future plans. In recent years, researchers have learned that adolescents do not simply internalize what teachers tell them in classrooms. Students attempt to make sense of new information based on meanings they personally construct, such as their attitudes toward mathematics.

However, research literature has failed to provide consistent findings regarding the relationship between math attitude and math achievement. A number of researchers have illustrated that the correlation between math attitude and math achievement is quite low, ranging from zero to .25, and they have concluded that attitude-achievement relationship is weak and cannot be considered to be practically significant (Abrego, 1966; Deighan, 1971; Vachon, 1984; Wolf & Blixt, 1981). Robinson (1975) concluded that math attitude accounts for at best 15% of the variance in math achievement, indicating that the relationship has no useful implications for educational practice.

On the other hand, researchers suggest that attitudes toward mathematics are extremely important in the achievement and participation of students in mathematics (Shashaani, 1995). For example, Gallagher and De Lisi (1994) identified a positive relationship between performance on standardized mathematics tests and positive attitudes toward mathematics. Attitudes can predict final mathematics course grade and are correlated with continuation in advanced mathematics courses once enrollment becomes optional (Thorndike-Christ, 1991). Enemark and Wise (1981) demonstrated that attitudes are significant indicators of math achievement and have strong relationships with math achievement even after background and academic orientation variables are controlled. Steinkamp (1982) concluded that the primary variables determining achievement in mathematics are attitude toward mathematics. These conclusions represent the view of a strong relationship between math attitude and math achievement, with correlations above .40, as supported by a number of researchers (Kloosterman, 1991; Minato; 1983, Minato & Yanase; 1984; Randhawa & Beamer, 1992).

In addition, other findings show that although the attitude-achievement relationship is statistically significant, it is not very strong from a practical perspective, with correlations ranging from .2 to .4 (Aiken, 1971; Anttonen, 1968; Beattie, Deichmann, & Lewis, 1973; Jacobs, 1974; Quinn, 1978). Aiken (1970) argued that the correlations between attitude and achievement in elementary school are typically not very large although statistically significant in certain instances. Later Aiken (1976) noted that the relationship between attitude and achievement is usually positive and meaningful at the elementary and secondary school, but may not always reach statistical significance.

*The Significance of Gender, Age and Ethnicity*

Previous studies have identified a number of factors having important effects on the relationship between attitude toward mathematics and mathematics achievement. Gender, grade, and ethnicity are the basic variables in the examination of this relationship. Demonstrating the effect of gender on the ATM-AIM relationship, Aiken (1970a) wrote in his review:

> No one would deny that sex can be an important moderator variable in the prediction of achievement from measures of attitudes and anxiety. The results of several of the investigations ... suggested that measures of attitudes and anxiety may be better predictors of the achievement of females than of males. (p. 567)

In a later review, Aiken (1976) reiterated that girls' mathematics achievements are more predictable from attitudes than are boys' achievement because the attitude-achievement correlation is generally somewhat higher for female students. He concluded that "it is clear that in prediction studies involving a measure of attitude toward mathematics, separate analyses by sex should always be conducted" (p. 302). However, researchers have indicated that male students always scored higher than female students on their attitude toward mathematics (Mapia

& Marsh, 2000). However, a study of 134 undergraduate students enrolled in mathematics classes found that the main effect of gender was insignificant with small effect size (Mapia & Marsh, 2002). In addition, a study exploring causal relationships between attitude toward mathematics and math achievement found no evidence of gender differences in the causal relationship between attitude and achievement (Ma & Xu, 2004). Male and female students shared the same effects between attitude and achievement, and males and females also showed similar stability effects for attitude and achievement. Finally, they concluded that the causal relationship between attitude and achievement is gender invariant.

Behr (1973) and Callahan (1971) noted that the correlation between attitude toward mathematics and mathematics achievement varies not only with gender but also with grade level. Aiken (1970, 1976) commented that attitude toward mathematics has a grade distribution, which requires separate accounts across grade levels. Specifically, Aiken (1970) found that the attitude-achievement correlations, "though statistically significant in certain instances, are typically not very large at the elementary level " (p. 559); there were "significant correlations between performance in mathematics and measures of attitudes and anxiety toward mathematics at the junior high level " (p. 560); "achievement was also greater for students whose attitudes had remained favorable or had become favorable since elementary school at the senior high level " (p. 560). Later, Aiken (1976) reported that "a low but significant positive correlation" existed at the elementary and secondary school levels (p. 295) and that "the correlation between attitude and achievement varies ... with grade level" (p. 296).

Within ethnic groups, there are culturally unique intellectual styles of learning (Lesser, Fifer, & Clark, 1965). Both the cross-sectional results from the National Assessment of Educational Progress (NAEP) and the longitudinal results from the National Longitudinal Study

(NLS) and the High School and Beyond (HSB) consistently indicate that the attitude toward mathematics gap among ethnic groups is great to start with, and increases as students get older (Secada, 1992). The hypothesis that mathematics achievement can be culturally shaped and reinforced has also been proposed recently (Lapointe, Mead, & Phillips, 1989; Lee, Ishikawa, & Stevenson, 1987; Robitaille & Garden, 1989; Robitaille & Travers, 1992). For example, Mapia and Marsh (2002) examined 545 students at a college preparatory bilingual school in Mexico City and found that there was an overall significant effect for ethnicity on students' attitude toward mathematics. Mexican students generally scored higher than American students. Students with dual citizenship, where students had one American parent, scored higher than Americans, too. However, Aiken (1979) found a low but significant positive attitude-achievement correlation not only for White students in the United States but also for students in other countries and from minority groups in the United States, indicating that the attitude-achievement relationship is similar among ethnic groups.

Recognizing the importance of attitudes, there is an increasing awareness of the need to examine attitudes and help students develop positive attitudes toward mathematics. However, there is a paucity of research about the different factors that influence the attitudes toward mathematics or an understanding of how and why they change over time.

*Instruments Measuring Attitudes toward Mathematics*

Several scales have been developed to assess attitudes toward mathematics in adults and adolescents. Generally each scale includes different factors. For example, Fennema and Sherman (1976) and Sandman (1973) developed and administrated questionnaires to secondary school students to evaluate a variety of feelings and beliefs pertaining to math, including attitudes about success in math, perceptions of encouragement by parents, perceptions of teachers' attitudes towards math, confidence in learning math, enjoyment of math, math anxiety, motivation in math, and utility of math. Another widely used measure is *The Attitudes toward Mathematics Instrument* (ATMI, Tapia, 1996). According to confirmatory factor analysis, four factors are included: self-confidence, value, enjoyment, and motivation. Research has concluded that this measure is valid for high school students and college students as well.

Some studies include difficulty of mathematics as variables to measure students' attitude toward mathematics (Ma & Xu, 2004). However, Ma (1997) argued that there is empirical evidence to show that difficulty is independent of other attitudinal measures. It seems reasonable to assume that difficulty is a kind of awareness or recognition, an attitudinal element that may encourage students to put more effort into learning mathematics. But successful efforts in bringing students to a better awareness of the difficulty of mathematics may not automatically improve other attitudinal aspects. On the other hand, either frustration or enjoyment in mathematics is unlikely to change the recognition of mathematics as an important discipline. Therefore, as Aiken (1970b) suggested, researchers or educators should be careful when using generic measures of attitude toward mathematics because even negative attitudes may contain some positive elements, such as the recognition of the importance of mathematics.

*Mathematics Anxiety and Attitudes toward Mathematics*

The relationship between mathematics anxiety and attitudes toward mathematics is becoming increasingly important because many researchers believe that mathematics anxiety is influenced by the beliefs and feelings individuals have about mathematics (Betz, 1978; Wigfield & Meece, 1988; Wright & Miller, 1981). Correlations between mathematics anxiety and attitudes toward math have often been found (Ramirez & Dockweiler, 1987). Terwilliger and Titus (1995) reported attitudes are inversely related to math anxiety. In addition, Marsh and

Tapia (2002) examined 134 college students enrolled in mathematics classes in a state university by asking them to complete the ATMI. They found there was an overall significant effect of math anxiety on math attitudes with large effect size. Students with no math anxiety scored significantly higher in enjoyment than students with a great deal of math anxiety in self-confidence and in motivation. Students with some math anxiety scored significantly higher in motivation than those with a great deal of math anxiety.

**Self-efficacy vs Attitudes toward Mathematics**

A new and particularly rich avenue of inquiry into mathematics attainment and ultimately into career development has been opened by the self-efficacy perspective on achievement behavior (Schunk, 1984). Bandura (1977) postulates that self-efficacy expectations are a person's beliefs concerning his or her ability to successfully perform a given task or behavior, are a major determinant of whether a person will attempt a given task, how much effort will be expended, and how much persistence will be displayed in pursuing the task in the face of obstacles. According to self-efficacy theory, perceived self-efficacy influences, and is in turn influenced by, thought patterns, affective arousal, and choice behavior as well as task performance (Bandura, 1986).

A topic of great interest to researchers examining applications of self-efficacy theory to educational attainment and career development is the relation of mathematics performance to mathematics self-efficacy (Betz & Hackett, 1983; Hackett, 1985). From the perspective of social learning theory, self-efficacy expectations are proposed to be an even more important factor influencing attitudes toward mathematics and mathematics performance as well as mathematics-related educational and career choices (Bandura, 1977; Hackett & Betz, 1981).

Preliminary studies on mathematics self-efficacy support the major role of self-efficacy expectations in the process of choosing a mathematics-related career. Results from these studies indicate that mathematics self-efficacy is significantly correlated both with attitudes toward mathematics and with the extent to which college students select mathematics-related majors. Hackett (1985) reported the results of a path analysis indicating that mathematics self-efficacy contributed more significantly than gender, years of high school mathematics, ACT mathematics score, or mathematics anxiety to predicting the choice of a mathematics-related college major. In addition, Siegel, Galassi, and Ware (1985) found that the self-efficacy model superior to a mathematics aptitude/mathematics anxiety model in predicting college students' performance on a mathematics exam.

Mathematics self-efficacy can be distinguished from other measures of attitudes toward mathematics in that mathematics self-efficacy is a situational or problem-specific assessment of an individual's confidence in her or his ability to successfully perform or accomplish a particular task or problem. In addition, Bandura (1986) considers self-efficacy to be more predictive of future performance than global indicators as confidence in learning mathematics. Generally speaking, instruments measuring attitudes toward mathematics include self-confidence or even self-efficacy as subscales because theoretically an individual's mathematics self-efficacy can illustrate his or her either positive or negative response to mathematics. Therefore, self-efficacy is more specific than individuals' general attitudes toward mathematics.

In addition, mathematics anxiety can be considered as a result of low mathematics self-efficacy, according to social learning theory. A person who feels anxious about mathematics almost cannot feel capable of doing mathematics. Thus, mathematics anxiety could be an indicator of mathematics self-efficacy, although they are different concept. Some mathematics anxiety measures do include self-efficacy as a subscale. Therefore, in this particular study, students' mathematics anxiety was measured.

Moreover, some researchers argued self-efficacy is a more important predictor of students' future mathematics achievement. However, few of them focus on what students believe about the importance of mathematics and relate the importance to students' mathematics anxiety. One of the purposes of this study was to understand do U.S. adolescents care about mathematics or do they feel mathematics important in their lives, even though they feel more anxious about mathematics than Asian students and do not perform as well as Asian students. So, particularly in this study, students' attitudes about the importance of mathematics were measured and discussed.

## Parents' and Peer's Influence

A growing body of literature has established the importance of parents' attitudes in influencing their adolescents' attitudes and achievement (Jacobs, 1991). Researchers have indicated that parents' attitudes are significantly related to student attitudes toward mathematics (Reynolds & Walberg, 1992). However, the effect of parents' attitudes on students' attitudes is cumulative. Students may considered mathematics more valuable and make higher achievement gains if they had parents with favorable attitudes towards mathematics. However, few of previous studies examine parents' mathematics anxiety and attitudes toward mathematics together and discuss the relationship between them. Moreover, limited studies relate parents' mathematics anxiety and attitudes toward mathematics to their adolescents' mathematics anxiety and attitudes toward mathematics, and to their adolescents' mathematics achievement.

Although parents can serve as powerful models for transmitting attitudes to children, peers' attitudes are also important factors influencing children's attitudes (Davidson & Smith, 1982). In the context of social and cognitive development, traditionally the adolescent peers have been established as a significant source for adolescents' development (Elkind, 1967; Flavell, 1985). The adolescent's ability to find, adjust, and maintain a "peer niche" predicts an adolescent's psychological well-beings and academic achievement (Brown, Eicher, & Petrie, 1986). For example, some researchers explored peer interaction and achievement patterns (Berndt, Perry & Miller, 1988; Schwartz, 1981). Specifically, Schwartz found that high school peers emerged within groups rather than across academic tracks. His findings also provided evidence to suggest that high-track students emphasized common goals, reinforcing their high-ability status. In contrast, low-track adolescents engaged in competitive, derogatory interactions that were counterproductive to achievement goals. Berndt et al. (1988) found if classroom peer groups held low self-esteem, over time, students motivation within groups declined.

Nichols and White (2001) conducted a study to examine the impact of peer networks on achievement of high school algebra students. Results provide supportive evidence for the positive influential power of students' peer networks and their potential impact of academic achievement. Their results also suggest a homogeneity of academic achievement among peer group members in regular-track courses, indicating that perhaps the peer group may not only affect achievement but also that successful achievement may be a factor that initially draws students together to form a peer group. In other words, students' attitude could be another factor to draw students together and influence each other. However, almost no attention has been given to peers' mathematics anxiety and attitudes toward mathematics, and related them to students' own mathematics anxiety and attitudes toward mathematics. In this particular study, adolescents' perceptions of peers' mathematics anxiety and attitudes toward mathematics were examined and the relationships with students' perceptions of their own mathematics anxiety and attitudes were explored as well.

## Ethnic Difference in Mathematics Achievement

Reports of American students' weaknesses in mathematics appear regularly in the popular and scientific press (Stevenson et al., 1990). Among these, the reports of cross-national studies of mathematics achievement have been especially disturbing. These studies document the profound underachievement in mathematics of American students compared to their peers in other nations. American secondary school students consistently demonstrated low average levels of performance in both the First and Second International Mathematics Studies (Garden, 1987; Husen, 1967). Moreover, a study examining students in the United States, Japan, and Taiwan indicated that deficiencies among American children appear as early as kindergarten and persist through elementary school (Stevenson, Lee, & Stigler, 1986).

The remarkable accomplishments inevitably lead to questions about how they are attained. Several possible reasons for the success of Asian students have been suggested (Chen & Stevenson, 1995). Some emphasize genetic factors, and others have discussed the beliefs, attitudes, and practices of parents, teachers, and students. For example, Crystal and Stevenson (1991) found that American mothers perceived their adolescents as having fewer problems in mathematics and judged these problems to be less serious and more transitory than did Asian mothers. American parents seemed to be less attentive to their adolescents' performance in mathematics and to be less sensitive to the problems their adolescents actually had than Asian parents. American parents were somewhat less likely to provide assistance to their adolescents. Their findings also suggested that American parents tend to evaluate their adolescents' mathematics skills uncritically and that their lack of awareness of the frequency or severity of adolescents' problems reduces their effectiveness as a source of help to their adolescents.

Asians have been found to place a high value on education, to emphasize the role of effort in academic achievement, to hold high standards and aspirations, to show more parental involvement in adolescents' learning and to devote more time to academic work (Chen & Stevenson, 1989; Stevenson, Lee, Chen, & Stigler et al., 1990; White, 1993). Furthermore, Chen and Stevenson conducted a comparative study of Asian, Asian-American, and Caucasian-American high school students to examine the relations between motivation and mathematics achievement. Findings suggested that factors associated with the achievement of Asian-American and Asian students included having parents and peers who hold high standards, believing that the road to success is through effort, having positive attitude about achievement, studying diligently, and facing less interference with their schoolwork from jobs and informal peer interactions.

The findings of these studies support a cultural-motivational theory of academic achievement (Chen & Stevenson, 1995). Beliefs and attitudes that lead to high level of motivation and achievement-related behaviors reflect a cultural heritage that emphasizes education and the ability of all persons to benefit intellectually from diligent application of effort. However, we know little about mainland China, which may hold different cultural heritage and beliefs than Taiwan, Japan and other Asian countries. Mainland China has a long tradition of reverence for education and studies have been demontrated that mainland-Chinese students' mathematics achievement is significantly higher than American students. But few studies recruited mainland-Chinese students as their samples and we know little about students' perceptions and their parents or peers' attitudes about mathematics learning and achievement.

## The Importance of High School

Numerous studies have shown significant relations between attitudes toward mathematics during the high school years and decisions to pursue careers in math and science. In fact, individuals in science careers, as compared with those in non-science careers, took more high school elective science courses and aspired to higher prestige careers as adolescents (Farmer et al., 1999). Because adolescents are influenced by their parents' and peers' perceptions and beliefs during high school (Bregman & Killen, 1999), students whose parents do not encourage them to take such classes will not encounter the experiences in math and science that help them develop needed levels of positive attitudes and self-efficacy to pursue math and science careers. Therefore, high school students are an appropriate sample in order to explore the relations among attitudes toward mathematics, mathematics anxiety and students' mathematics achievement.

# CHAPTER THREE

# METHODOLOGY

## Sample

A total of one hundred and thirty four high school students were recruited for this study (from $10^{th}$ to $12^{th}$ grade). Eighty $10^{th}$ grade Mainland-Chinese students were recruited from Chengdu, China and 54 European-American students ($10^{th}$ to $12^{th}$ grade) were recruited from a northwest city in the United States. Institutional Review Board approval was granted (IRB number is 9435). A convenience sample was used with intact classrooms and voluntary participants. A power analysis was conducted prior to collecting data. Based on $p < .05$, a large effect size (.8) and power equals 1.0, a sample size larger than 50 was acceptable.

For the Mainland-Chinese students, 55.7% were males and 44.3% were females while for the European-American students, the numbers of males and females were equal (50%). All Mainland-Chinese adolescents were $10^{th}$ grade and from the same ethnic group. The majority of European-American students were from $12^{th}$ grade (61.1%, see Table 1) and were Caucasian (83.3%, see Table 1). Seventy-four percent of Mainland-Chinese adolescents reported their parents hold a college degree while ninety-six percent of European-American adolescents reported their parents had a college degree (see Table 1). Given this educational background, it appears that both Mainland-Chinese and European-American adolescents in this sample can be considered to have a middle class socioeconomic status.

Table 1

*Demographic Comparisons of Mainland-Chinese and European-American Adolescents*

| | Ethnic group | | | |
|---|---|---|---|---|
| | Mainland-Chinese | | European-American | |
| Characteristics | N | Percent | N | Percent |
| *Gender of students* | | | | |
| Male students | 44 | 55.7% | 27 | 50% |
| Female students | 35 | 44.3% | 27 | 50% |
| *Grade of students* | | | | |
| 10th grade | 80 | 100% | 2 | 3.7% |
| 11th grade | | | 19 | 35.2% |
| 12th grade | | | 33 | 61.1% |
| *Ethnicity of students* | | | | |
| Asian/Pacific Island | | | 8 | 14.8% |
| African American | | | 1 | 1.9% |
| White | | | 45 | 83.3% |
| *Parents' Highest Education* | | | | |
| Some high school | 3 | 3.8% | 1 | 1.9% |
| High school | 17 | 21.8% | 1 | 1.9% |
| Some college | 18 | 23.1% | 2 | 3.7% |
| College | 31 | 39.7% | 21 | 38.9% |
| Graduate/Professional | 9 | 11.5% | 29 | 53.7% |

## Procedures

Principals from each high school were contacted to be introduced to the study and allowed to ask questions. After achieving permission from the school principals, the investigator sent each student a package including a cover letter explaining the study and invitation to participate, a written consent form for the student's parents to sign (see Appendix A), a written assent form for student to sign (see Appendix B) and questionnaires for students to complete. The questionnaires included an examination of adolescents' perception of parents' math anxiety and math attitudes, adolescents' perception of peers' math anxiety and math attitudes, and adolescents' math attitude and math anxiety. American students who agreed to participate in this study completed the questionnaires in their math class and returned both forms their classroom teachers. A graduate student from Sichuan University was the investigator in China. Chinese students completed questionnaires at home and brought both forms to their classroom teachers. The Chinese investigator collected questionnaires and signed forms from students' classroom teachers and sent all the data back to the United States.

Students in the United States were given questionnaires in English whereas students in China were given questionnaires that had been translated into Chinese. In this study, the lead researcher translated all the materials into Chinese while a native Chinese speaker back translated the materials into English. Discrepancies were evaluated and changes were made. This method of forward and back translation has been shown to be an acceptable method for ensuring that questionnaires were translated correctly across languages (Kelly & Tseng, 1992).

## Instruments

The questionnaire was divided into two parts: demographic information and math anxiety and attitudes toward mathematics questionnaires (see Appendix C). For each student, their perceptions of their parents' and their peers' math anxiety and math attitudes were examined. Demographic information consists of students' grade, gender, ethnicity, and parents' highest educational level. Finally, students were asked to rate their general mathematics achievement based on a 5-point scale from 1 = extremely low level to 5 = high level. Three domains were measured in this particular study: mathematics anxiety, attitudes toward mathematics and mathematics achievement.

*Mathematics Anxiety*

The revised model of Math Anxiety Rating Scale-Revised (MARS-R, Plake & Parker, 1982) was used to measure students' mathematics anxiety (see Appendix C). The MARS-R was designed based on a multilevel model of math anxiety in which the construct is perceived as highly associated with situation-specific anxiety, general anxiety and text anxiety. The instrument has 24 items and two subscales: learning math anxiety (LMA), which relates to anxiety about the process of learning, and math evaluation anxiety (MEA), which is more directly related to testing situations. The MARS-R, which has yielded a coefficient alpha reliability of .98, is correlated .97 with the full-scale MARS. The revised model of MARS-R only has 12 items. Having dropped 8 of the 16 items from the LMA subscale, the revised 8-item subscale correlated strongly with the original 16-item scale ($r = .98$, $p < .001$). Similarly, having dropped 4 of the 8 items from the MEA subscale, the revised 4-item subscale correlated strongly with the original 8-item scale ($r = .95$, $p < .001$). The revised 12-item model also correlated strongly with the MARS-R ($r = .97$, $p < .001$). Reliability coefficients for the two factors of the revised model are as follows: LMA, $\alpha = .87$; MEA, $\alpha = .85$. The two factors are highly correlated ($r = .72$). The reliability coefficients in this study for both European-American and Mainland-Chinese samples were acceptable, ranging from $\alpha = .83$ to $\alpha = .92$ (see Table 2).

Table 2

*Reliability for All Measures*

| | Cronbach's Alphas | |
|---|---|---|
| Measures | Mainland-Chinese | European-American |
| Adolescent Math Anxiety | .89 | .83 |
| Adolescent Math Attitude | .79 | .87 |
| Peers' Math Anxiety | .85 | .84 |
| Peers' Math Attitude | .77 | .79 |
| Parents' Math Anxiety | .92 | .89 |
| Parents' Math Attitude | .81 | .86 |

Items were answered on a 5-point Likert-type scale ranging from 1 (no anxiety) to 5 (high anxiety). An interval level of measurement was obtained by summing total scores. The higher the total score, the higher the math anxiety. Sample items for the LMA subscale were "looking through the pages in a math text", and "having to use the tables in the back of a math book". Sample item for MEA subscale were "Thinking about an upcoming math test one day before" and "being given a pop quiz in math class".

Students' perceptions of their parents' and peers' math anxiety were also measured by MARS-R. Students were asked to rate their parents or their peers' math anxiety based on these 12 items. Key words such as "Parents" and "Peers" were emphasized in the instruments. Instruments were printed on a different color paper for the students, perceptions of parents and perceptions of peers.

*Attitudes toward Mathematics*

The Attitudes toward Mathematics Inventory (ATMI) was used to measure students' attitudes toward mathematics (Tapia, 1996; see Appendix C). The ATMI consists of 40 items including four subscales: self-confidence, value, enjoyment, and motivation. Alpha coefficients for the scores of these scales were found to be .95, .89, .89, and .88 respectively. The value scale consisted of 10 items, with questions constructed using a likert –type scale from 1 = strongly disagree to 5 = strongly agree. Sample items for the value subscale were "mathematics is a very worthwhile and necessary subject.", "Mathematics will be very helpful no matter what I decide to study.", and "Mathematics is important in everyday life." The reliability coefficients for this questionnaire for both European-American and Mainland-Chinese samples were acceptable, ranging from $\alpha$ =.77 to $\alpha$ =.87, respectively (see Table 2).

Students' perceptions of their parents' and peers' attitudes toward mathematics were measured using the revised version of the ATMI. "My parents believe" or "My friends believe" were added at the very beginning of each item on the ATMI. Students rated their response on a 5-point Likert-type scale from strongly disagree to strongly agree. Instruments were printed on different color paper for students, parents and peers. An interval level of measurement was obtained by summing total scores. The higher the total score, the more valuable students think about mathematics.

## Data Analysis

Prior to data analysis, all variables were examined for missing values, outliers, linearity and normality. Because Likert-type scales are ordinal in nature, the missing values were replaced by the middle level of the scale: three. Frequency analysis was run for all variables and mahalanobis distance was conducted to examine the multivariate outliers. Normal Q-Q plot, detrended normal Q-Q plot and Kolmogorov-Smirnov statistic were conducted to examine the normality of the data set.

Descriptive analyses were conducted for both European-American and Mainland-Chinese questionnaires. Correlations among each scale, adolescents' math achievement, and their parents' highest education level were conducted for each group by using Pearson r correlation. One two-way MANOVA was conducted to examine ethnicity and gender difference in students' perception of parents' math anxiety and math attitudes. One two-way MANOVA was conducted to examine ethnicity and gender difference in students' perceptions of peers while a third two-way MANOVA was conducted to examine ethnicity and gender differences with students' own perceptions. Multiple regression analysis was conducted to find the predictions of perceptions of students, parents and peers on students' mathematics achievement in both Mainland-Chinese and European-American groups (see Table 3). Effect size and reported power are reported with significant main or interaction effects. Contrast was performed on significant interactions. Alpha level was set a $p < .05$.

Table 3

*Data Analysis*

| | Independent Variables | Dependent Variables | Data Analysis |
|---|---|---|---|
| Null Hypotheses: | | | |
| 1 | Ethnicity & Gender | Perceptions of Parents' Math anxiety and Math attitudes | Two-Way MANOVA |
| 2 | Ethnicity & Gender | Perceptions of Peers' Math anxiety and Math attitudes | Two-Way MANOVA |
| 3 | Ethnicity & Gender | Perceptions of Adolescents' Math anxiety and Math attitudes | Two-Way MANOVA |
| Additional Research Questions (for each ethnic group) | | | |
| 1-2 | Perceptions of parents' and peers' math anxiety | Adolescents' math anxiety | Multiple Regression |
| 3-4 | Perceptions of parents' and peers' math attitudes | Adolescents' Math attitudes | Multiple Regression |
| 5-6 | Perceptions of parents' math anxiety and attitudes | Adolescents' math achievement | Multiple Regression |
| | Perceptions of peers' math anxiety and attitudes | Adolescents' math achievement | Multiple Regression |
| | Adolescents' math anxiety and math attitudes | Adolescents' math achievement | Multiple Regression |

# CHAPTER FOUR

# RESULTS

## Context

The primary purpose of this study was to examine the similarities and differences in adolescents' perception of their parents', peers' and their own mathematics anxiety and attitudes toward mathematics between European-American and Mainland-Chinese groups. The second goal of this study was to examine whether adolescents' perception of their parents', peers' and their own mathematics anxiety and attitudes toward mathematics would predict their mathematics achievement in both European-American and Mainland-Chinese groups

The results are presented in four parts. First, descriptive statistics of each measure are presented. Second, correlations among each measure and their relationships to parents' highest education level are reported. Third, I compared the similarities and differences between European-American and Mainland-Chinese adolescents' perceptions of their parents', peers' and their own math anxiety and attitudes toward mathematics. Finally, I examined whether adolescents' perception of parents', peers' and their own math anxiety and attitude predict their math achievement for each ethnic group.

## Descriptive Statistics

For each student, a total score of each scale was calculated, thus each instruments' Likert scale data were converted to interval level data. Each variable was examined for missing data, normality and multivariate outliers. This examination revealed one outlier in the European-American sample. Because the distance between this outlier and the rest of the data was not very great, I decided to keep this outlier while conducting data analysis. A summary of the means and standard deviations of each scale can be found in Table 4.

TABLE 4

*Mean and Standard Deviation of All Measures*

| | Ethnic group | | | |
|---|---|---|---|---|
| | Mainland-Chinese | | European-American | |
| Measures | M | SD | M | SD |
| Adolescent Math Anxiety | 30.78 | 8.09 | 32.02 | 8.79 |
| Adolescent Math Attitude | 39.81 | 6.21 | 39.19 | 6.02 |
| Peers' Math Anxiety | 33.38 | 8.66 | 37.46 | 7.88 |
| Peers' Math Attitude | 37.55 | 6.24 | 30.94 | 6.04 |
| Parents' Math Anxiety | 29.86 | 10.26 | 29.61 | 10.49 |
| Parents' Math Attitude | 40.33 | 6.43 | 42.59 | 7.07 |
| Adolescent math achievement | 3.25 | .77 | 4.09 | .62 |

## Correlations

Correlations among each scale, adolescents' self-reported mathematics achievement, and their parents' highest education attainment were calculated separately for the European-American group and Mainland-Chinese group by using Pearson r correlations (see Table 5 and Table 6, respectively). For the Mainland-Chinese group, adolescents' perceptions of their own mathematics anxiety was positively related to adolescents' perceptions of their peers' mathematics anxiety ($r = .59$, $r^2 = .35$, $p < .01$), adolescents' perceptions of their parents' anxiety

($r = .36$, $r^2 = .13$, $p < .01$) and negatively related to the perceptions of their own mathematics achievement ($r = -.51$, $r^2 = .26$, $p < .01$). Adolescents' perceptions of their own math attitudes were positively related to their perceptions of peers' math attitudes ($r = .38$, $r^2 = .14$, $p < .01$), their perceptions of parents' math attitudes ($r = .51$, $r^2 = .26$, $p < .01$), the perceptions of their own math achievement ($r = .27$, $r^2 = .07$, $p < .05$), and negatively related to their parents' highest educational level ($r = -.24$, $r^2 = .06$, $p < .05$). Adolescents' perceptions of peers' math anxiety was positively related to their perceptions of parental math anxiety ($r = .37$, $r^2 = .14$, $p < .01$), and negatively related to the perceptions of their own math achievement ($r = -.26$, $r^2 = .07$, $p < .05$). In addition, adolescents' perceptions of their parents' math anxiety was negatively related to the perceptions of their own math achievement ($r = -.29$, $r^2 = .08$, $p < .01$), and their perceptions of parents' math attitudes ($r = -.31$, $r^2 = .10$, $p < .01$).

For the European-American group, adolescents' mathematics anxiety was positively related to adolescents' perceptions of their peers' mathematics anxiety ($r = .44$, $r^2 = .20$, $p < .01$) and adolescents' perceptions of their parents' anxiety ($r = .46$, $r^2 = .21$, $p < .01$), but negatively related to the perceptions of their own mathematics achievement ($r = -.35$, $r^2 = .12$, $p < .01$). Adolescents' math attitudes were positively related to their perceptions of parents' math attitudes ($r = .32$, $r^2 = .10$, $p < .05$), and the perceptions of their own math achievement ($r = .35$, $r^2 = .12$, $p < .05$). Adolescents' perceptions of peers' math anxiety were positively related to perceptions of parents' math anxiety ($r = .56$, $r^2 = .31$, $p < .01$). Adolescents' perceptions of parents' math attitudes were related to their parents' highest education level ($r = .57$, $r^2 = .33$, $p < .01$). Adolescents' perceptions of parents' math attitudes were positively related to their perceptions of peers' math attitudes ($r = .55$, $r^2 = .30$, $p < .01$), and negatively related to perceptions of parents' math anxiety ($r = -.29$, $r^2 = .08$, $p < .05$).

TABLE 5

*Correlations of Measures for Mainland-Chinese Adolescents*

| | AD_ANX | AD_ATT | PEER_ANX | PEER_ATT | PARE_ANX | PARE_ATT | PARE_EDU | AD_MATH ACH |
|---|---|---|---|---|---|---|---|---|
| AD_ANX | 1 | | | | | | | |
| AD_ATT | -.217 | 1 | | | | | | |
| PEER_ANX | .593** | -.025 | 1 | | | | | |
| PEER_ATT | -.177 | .379** | -.079 | 1 | | | | |
| PARE_ANX | .357** | -.183 | .366** | -.118 | 1 | | | |
| PARE_ATT | -.035 | .513** | .019 | .179 | -.312** | 1 | | |
| PARE_EDU | -.133 | -.235* | -.193 | -.047 | -.177 | .004 | 1 | |
| AD_MATH_ACH | -.512** | .269* | -.263* | .171 | -.288** | .139 | .052 | 1 |

* $p < .05$, ** $p < .01$

TABLE 6

*Correlations of Measures for European-American Adolescents*

| | AD_ANX | AD_ATT | PEER_ANX | PEER_ATT | PARE_ANX | PARE_ATT | PARE_EDUC | AD_MATH_ACH |
|---|---|---|---|---|---|---|---|---|
| AD_ANX | 1 | | | | | | | |
| AD_ATT | -.245 | 1 | | | | | | |
| PEER_ANX | .439** | .092 | 1 | | | | | |
| PEER_ATT | -.001 | .065 | -.157 | 1 | | | | |
| PARE_ANX | .447** | -.041 | .556** | -.094 | 1 | | | |
| PARE_ATT | .091 | .319* | .061 | .554** | -.286* | 1 | | |
| PARE_EDUC | .250 | .031 | .082 | .101 | -.202 | .572** | 1 | |
| AD_MATH_ACH | -.352** | .353* | -.009 | .017 | -.064 | .232 | .185 | 1 |

* $p < .05$, ** $p < .01$

## Testing of Hypotheses

*Hypothesis 1: No difference exists by ethnicity, gender or by interaction between ethnicity and gender on European-American and Mainland-Chinese adolescents' perceptions of parental math anxiety and math attitudes.*

In order to compare differences between European-American and Mainland-Chinese adolescents' perceptions of their parents' mathematics anxiety and attitudes toward mathematics, a MANOVA was conducted. Ethnic group and adolescents' gender served as independent variables while perceptions of parents' mathematics anxiety and mathematics attitudes served as dependent variables. No significant group effect (Wilk's $\lambda$ = .969, $F$ (2, 129) = 2.043, $p$ = .134, partial $\eta^2$ = .031, 1-$\beta$ = .415) and gender effect on math anxiety and math attitudes (Wilk's $\lambda$ = .990, $F$ (2, 129) = .654, $p$ = .521, partial $\eta^2$ = .010, 1-$\beta$ = .158) was found. No interaction effect was found between ethnicity and adolescents' gender on adolescents mathematics anxiety and mathematics attitudes (Wilk's $\lambda$ = .989, F (2, 129) = .710, $p$ = .494, partial $\eta^2$ = .011, 1-$\beta$ = .168). It has been suggested that European-American adolescents and Mainland-Chinese adolescents hold similar perceptions of their parental math anxiety and attitudes toward mathematics (see Figure 2).

*Hypothesis 2: No difference exists by ethnicity, gender or by interaction between ethnicity and gender on European-American and Mainland-Chinese adolescents' perceptions of their peers' math anxiety and math attitudes.*

To compare differences between European-American and Mainland-Chinese adolescents' perception of their peers' mathematics anxiety and attitudes toward mathematics, a MANONA was conducted. Ethnic group and adolescents' gender served as independent variables while perceptions of peers' mathematics anxiety and mathematics attitudes served as dependent variables. A significant group effect was found (Wilk's $\lambda$ = .763, $F$ (2, 129) = 20.062, $p$ < .001, partial $\eta^2$ = .237, 1-$\beta$ = 1.000); while adolescents' gender has no main effect on their perceptions of their peers' math anxiety and math attitudes (Wilk's $\lambda$ = .998, $F$ (2, 129) = .129, $p$ = .880, partial $\eta^2$ = .002, 1-$\beta$ = .069). No interaction effect was found between ethnicity and adolescents' gender on adolescents' perception of peers' mathematics anxiety and mathematics attitudes (Wilk's $\lambda$ = .999, $F$ (2, 129) = .073, $p$ = .930, partial $\eta^2$ = .001, 1-$\beta$ = .061).

A univariate ANOVA was conducted as a follow-up test. With the follow-up analysis, group effect was found on adolescents' perceptions of peers' attitudes toward mathematics, $F$ (1, 129) = 36.100, $p$ < .001, partial $\eta^2$ = .217, 1-$\beta$ = 1.000, and on adolescents' perceptions of peers' mathematics anxiety $F$ (1, 129) = 7.56, $p$ = .007, partial $\eta^2$ = .055, 1-$\beta$ = .779. European-American adolescents ($M$ = 37.463, $SEM$ = 1.145) view their peers as more anxious than Mainland-Chinese adolescents ($M$ = 33.381, $SEM$ = .945). Mainland-Chinese adolescents ($M$ = 37.518, $SEM$ = .697) view their peers as holding more positive attitudes toward mathematics than European-American adolescents ($M$ = 30.944, $SEM$ = .844, see Figure 2)

*Hypothesis 3: No difference exists by ethnicity, gender or by interaction between ethnicity and gender on European-American and Mainland-Chinese adolescents' perceptions of math anxiety and math attitudes.*

In order to compare differences between European-American and Mainland-Chinese adolescents' mathematics anxiety and attitudes toward mathematics, a MANOVA was conducted. Ethnic group and adolescents' gender served as independent variables while perceptions of parents' mathematics anxiety and mathematics attitudes served as dependent variables. No significant group effect (Wilk's $\lambda$ = .994, $F$ (2, 129) = .388, $p$ = .679, partial $\eta^2$ = .006, 1-$\beta$ = .111) and gender effect on math anxiety and math attitudes (Wilk's $\lambda$ = .986, $F$ (2, 129) = .915, $p$

= .403, partial $\eta^2$ = .014, 1-$\beta$ = .205) was found. No interaction effect was found between ethnicity and adolescents' gender on adolescents mathematics anxiety and mathematics attitudes (Wilk's $\lambda$ = .980, F (2, 129) = 1.338, $p$ = .266, partial $\eta^2$ = .020, 1-$\beta$ = .285). It has been suggested that European-American adolescents and Mainland-Chinese adolescents hold almost the same attitudes toward mathematics and same level of mathematics anxiety (see Figure 2).

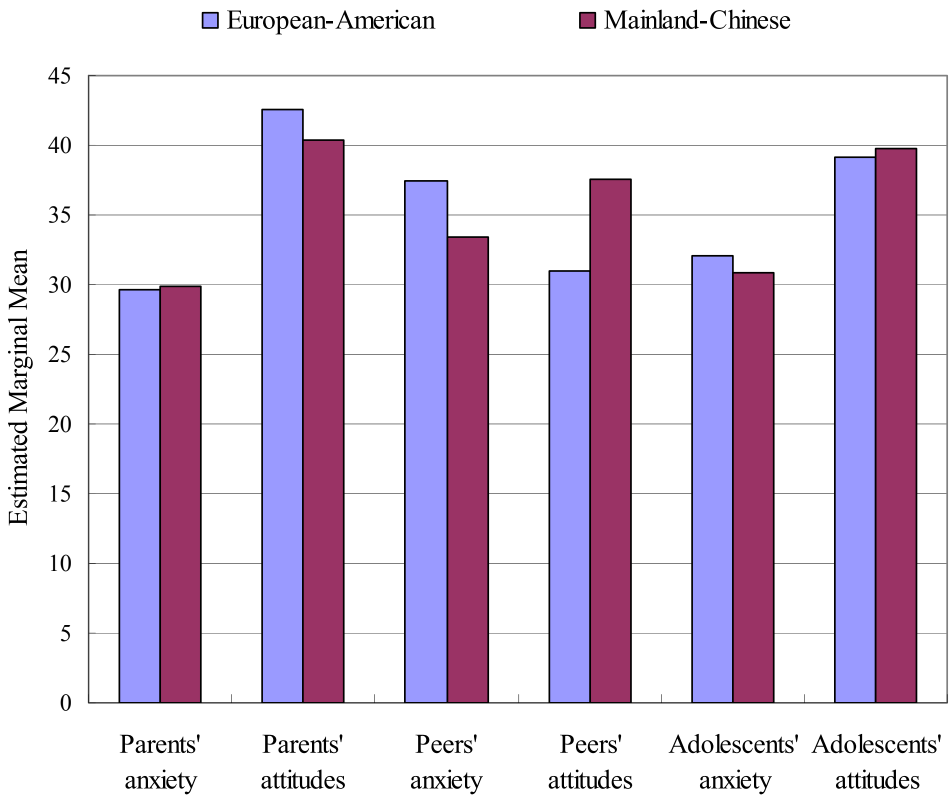


*Figure 2.* Comparison of Adolescents' Perceptions of Parents, Peers' and Their Mathematics Anxiety and Attitudes toward Mathematics

*Additional Research Questions*

The second primary purpose of this study was to examine whether adolescents' perception of their parents', peers' and their own mathematics anxiety and attitudes toward mathematics would predict their perceptions of their own mathematics achievement. In order to understand the relationships among those variables, a number of multiple regression analyses were undertaken separately for European-American and Mainland-Chinese group.

*Adolescents' Mathematics Anxiety.* A multiple regression analysis was conducted in each group. Adolescents' mathematics anxiety served as dependent variable while their perceptions of parents' and peer's mathematics anxiety served as independent variables. Adolescents' perception of their parents' and peers' mathematics anxiety predicted their own mathematics anxiety for both European-American adolescents ($R^2 = .272$, $\Delta R^2 = .244$, $F$ (2, 51) = 9.545, $p < .01$) and Mainland-Chinese adolescents ($R^2 = .375$, $\Delta R^2 = .358$, $F$ (2, 77) = 23.060, $p < .01$). The beta weight showed that for European-American adolescents, their perceptions of both parents' ($\beta = .306$, $p < .05$) and peers' anxiety ($\beta = .289$, $p < .05$) predicted their own anxiety (see Table 7). However, for Mainland-Chinese adolescents, their perception of peers' anxiety significantly predicted their own anxiety ($\beta = .534$, $p < .01$) but parents' anxiety did not predict their own anxiety ($\beta = .161$, $p = .101$).

*Adolescents' Mathematics Attitudes.* A multiple regression analysis was conducted with each group. Adolescents' mathematics attitudes served as dependent variable while their perceptions of parents' and peer's mathematics attitudes served as independent variables. European-American adolescents' perception of their parents' and peers' mathematics attitudes did not predict the perceptions of their own mathematics attitudes ($R^2 = .012$, $\Delta R^2 = -.027$, $F$ (2, 51) = .297, $p = .744$). Mainland-Chinese adolescents' perception of their parents' and peers' mathematics attitudes predicted the perceptions of their own mathematics attitudes ($R^2 = .349$, $\Delta R^2 = .332$, $F$ (2, 77) = 20.63, $p < .01$). Concerning beta weights, Mainland-Chinese adolescents' perceptions of their parents' ($\beta$ = .444, $p < .01$) and peers' mathematics attitudes ($\beta$ = .295, $p < .01$) significantly predicted their own mathematics attitudes (see Table 8).

*Adolescents' Mathematics Achievement.* In order to examine the predictors of adolescents' perceptions of their own mathematics achievement, three multiple regression analyses were conducted for each ethnic group. In the first regression analysis, adolescents' perception of their parents' mathematics anxiety and mathematics attitudes served as independent variables and adolescents' perceptions of their own mathematics achievement served as the dependent variable. Mainland-Chinese adolescents' perception of their parents' mathematics anxiety and attitudes significantly predicted their perceptions of their own mathematics achievement ($R^2$ = .086, $\Delta R^2$ = .062, $F$ (2, 77) = 3.614, $p$ = .032) while European-American adolescents' perception of their parents' math anxiety and attitudes did not predict their perceptions of their own math achievement ($R^2$ = .062, $\Delta R^2$ = .025, $F$ (2, 51) = 1.684, $p$ = .196). With respect to beta weights, Mainland-Chinese adolescents' perception of their parents' anxiety negatively predicted adolescents' perceptions of their own mathematics achievement ($\beta$ = -.271, $p$ = .020, See Table 9) while parents' math attitudes did not predict adolescents' perceptions of their own math achievement ($\beta$ = .054, $p$ = .636).

The second regression was conducted by using adolescents' perception of peers' mathematics anxiety and attitudes as the independent variables. Mainland-Chinese adolescents' perception of their peers' mathematics anxiety and attitudes significantly predicted their perceptions of their own mathematics achievement ($R^2$ = .092, $\Delta R^2$ = .068, $F$ (2, 77) = 3.884, $p$ = .025) while European-American adolescents' perception of their parents' math anxiety and attitudes did not predict their perceptions of their own math achievement ($R^2$ = .001, $\Delta R^2$ = -.038, $F$ (2, 51) = .036, $p$ = .965). With respect to beta weights, Mainland-Chinese adolescents' perception of their peers' anxiety negatively predicted adolescents' perceptions of their own mathematics achievement ($\beta$ = -.251, $p$ = .024, See Table 10) while peers' math attitudes did not predict adolescents' perceptions of their own math achievement ($\beta$ = .151, $p$ = .169).

The third regression analysis was conducted by using adolescents' perceptions of their own mathematics anxiety and attitudes toward mathematics as the independent variables. European-American adolescents' perceptions of mathematics anxiety and attitudes ($R^2$ = .220, $\Delta R^2$ = .168, $F$ (2, 51) = 6.359, $p$ < .01) and Mainland-Chinese adolescents' mathematics anxiety and attitudes ($R^2$ = .288, $\Delta R^2$ = .270, $F$ (2, 77) = 15.592, $p$ < .001) significantly predicted their perceptions of their own math achievement. With respect to beta weights, Mainland-Chinese adolescents' perceptions of their own mathematics anxiety negatively predicted adolescents' mathematics achievement ($\beta$ = -.476, $p$ < .001, See Table 11) while their perceptions of math attitudes did not predict their perceptions of their own math achievement ($\beta$ = .166, $p$ = .097). European-American adolescents' perceptions of mathematics anxiety negatively predicted adolescents' perceptions of their own mathematics achievement ($\beta$ = -.282, $p$ = .033, See Table 11) and their perceptions of math attitudes positively predicted their perceptions of their own math achievement ($\beta$ = .284, $p$ = .033).

TABLE 7.

*Summary of Regression Analyses of Parents' and Peers' Mathematics Anxiety on Adolescents' Mathematics Anxiety*

| | *European-American Adolescents' Mathematics Anxiety* | | | *Mainland-Chinese Adolescents' Mathematics Anxiety* | | |
|---|---|---|---|---|---|---|
| Variable | β | t | Sig. | β | t | Sig. |
| Parents' Mathematics anxiety | .306* | 2.159 | .036 | .161 | 1.662 | .101 |
| Peers' Mathematics anxiety | .289* | 2.040 | .047 | .534** | 5.518 | < .001 |

* $p < .05$, ** $p < .01$

TABLE 8.

*Summary of Regression Analyses of Parents' and Peers' Mathematics Attitudes on Adolescents' Mathematics Attitudes*

| | *European-American Adolescents' Mathematics Attitudes* | | | *Mainland-Chinese Adolescents' Mathematics Attitudes* | | |
|---|---|---|---|---|---|---|
| Variable | β | t | Sig. | β | t | Sig. |
| Parents' Mathematics attitudes | .104 | .615 | .542 | .444** | 4.926 | .002 |
| Peers' Mathematics attitudes | .125 | .734 | .467 | .295** | 3.175 | < .001 |

* $p < .05$, ** $p < .01$

TABLE 9.

*Summary of Regression Analyses of Parents' Mathematics Anxiety and Attitudes on Adolescents' Mathematics Achievement*

| | *European-American Adolescents' Mathematics Achievement* | | | *Mainland-Chinese Adolescents' Mathematics Achievement* | | |
|---|---|---|---|---|---|---|
| Variable | β | t | Sig. | β | t | Sig. |
| Parents' Mathematics anxiety | -2.025 | -1.818 | .075 | -.271* | -2.366 | .020 |
| Parents' Mathematics attitudes | 1.976 | 1.774 | .082 | .054 | .475 | .636 |

* $p < .05$, ** $p < .01$

TABLE 10.

*Summary of Regression Analyses of Peers' Mathematics Anxiety and Attitudes on Adolescents' Mathematics Achievement*

| | *European-American Adolescents' Mathematics Achievement* | | | *Mainland-Chinese Adolescents' Mathematics Achievement* | | |
|---|---|---|---|---|---|---|
| Variable | β | t | Sig. | β | t | Sig. |
| Peers' Mathematics anxiety | -.163 | -.260 | .812 | -.251* | -2.299 | .024 |
| Peers' Mathematics attitudes | .150 | .239 | .796 | .151 | 1.388 | .159 |

* *p* < .05, ** *p* < .01

TABLE 11.

*Summary of Regression Analyses of Adolescents' Mathematics Anxiety and Attitudes on Adolescents' Mathematics Achievement*

| | *European-American Adolescents' Mathematics Achievement* | | | *Mainland-Chinese Adolescents' Mathematics Achievement* | | |
|---|---|---|---|---|---|---|
| Variable | β | t | Sig. | β | t | Sig. |
| Adolescents' Mathematics anxiety | -.282* | -2.185 | .033 | -.476** | -4.833 | < .001 |
| Adolescents' Mathematics attitudes | .284* | 2.197 | .033 | .166 | 1.683 | .097 |

* *p* < .05, ** *p* < .01

# CHAPTER FIVE

# DISCUSSION

## Summary of Results

Researchers have suggested that for some time now American secondary school students perform poorly on tests of mathematics achievement compared to students from many Asian countries, such as Mainland China and Japan. Mathematics anxiety and individuals' attitudes toward mathematics have been suggested to be very important to students' mathematics achievement in European-American settings. However, few researchers have examined these constructs in Mainland-Chinese settings. The first goal of this study was to examine the similarities and differences in adolescents' perception of their parents', peers' and their own mathematics anxiety and attitudes toward mathematics between European-American and Mainland-Chinese groups. Second, this study sought to find whether adolescents' perception of their parents', peers' and their own mathematics anxiety and attitudes toward mathematics would predict their perceptions of their personal mathematics achievement in both European-American and Mainland-Chinese groups.

Based upon previous research, it was expected that European-American and Mainland-Chinese adolescents would have different perceptions of their parents', peers' and their own mathematics anxiety and attitudes toward mathematics. Meanwhile, it was expected that European-American students would have a higher level of mathematics anxiety and more negative mathematics attitudes compared to Mainland-Chinese students. European-American students think their parents and peers would feel more anxious and hold more negative attitudes toward mathematics than would Mainland-Chinese students. In addition, for both groups, it would be expected that adolescents' perceptions of their parents' and peers' mathematics anxiety and attitudes toward mathematics would predict their own math anxiety and math attitudes. Meanwhile, adolescents' perceptions of their parents', peers', and their own math anxiety and math attitudes would predict their mathematics achievement.

With respect to these expectations, it was found that there were significant ethnic differences in perceptions of their parents' math anxiety, peers' math anxiety and math attitudes between European-American and Mainland-Chinese adolescents. European-American adolescents believed that their peers were more anxious about mathematics compared to Mainland-Chinese adolescents. Mainland-Chinese adolescents believed that peers held more positive attitudes toward mathematics compared to European-American adolescents. For both ethnic groups, adolescents' perceptions of peers' math anxiety predicted their perceptions of their own math anxiety. In addition, adolescents' perceptions of their own math anxiety negatively predicted their perceptions of their own math achievement.

However, some results were not consistent with what was expected. For example, European-American and Mainland-Chinese adolescents felt that their parents held similar math anxiety and similar math attitudes. European-American adolescents viewed themselves having similar math anxiety and math attitudes as Mainland-Chinese adolescents. With respect to Mainland-Chinese students, adolescents' perceptions of parental and peers' math attitudes predicted their own math attitudes. Mainland-Chinese students' perceptions of parental math anxiety did not predict their own math anxiety but did predict their math achievement.

## Discussion

Schooling is a cultural institution, and a more detailed analysis reveals the subtle and pervasive effects of culture as it impinges on adolescents' learning of mathematics: in the curriculum, in the organization and functioning of the classroom, and in the beliefs and attitudes about learning mathematics (Stigler & Perry, 1988). The decision to compare mathematics anxiety and attitudes toward mathematics in Asian and American adolescents is not arbitrary. We have known for some time now that American secondary school students compare poorly on tests of mathematics achievement with students from many other countries, but especially with students from Japan and China. Explaining differences presents a challenge to researchers and also educators who must grapple with the problem of declining mathematics competence in American society (McKnight et al., 1987).

Where should we look for explanations? The fundamental problem we encounter is that on almost every dimension with which we could compare Asian countries with the United States proves to differentiate these societies. For example, American society is founded on capitalism and Chinese society is founded on socialism. The United States has a different educational system from Mainland China, such as curriculum, instructional method, classroom assessment and university recruiting processes. Given this enormous confounding of factors, it is almost impossible to tell which are causally related to differences in learning and which are only related by chance. There is much to learn by understanding the way cultural and educational resources are marshaled to produce the higher achievement produced by Asian societies.

The focus of this study was to compare ethnic differences in adolescents' math anxiety and attitudes toward math, and their perceptions of parental and peers' math anxiety and math attitudes between European America and Mainland China. A problem arises when significant ethnic differences are found concerning what the ethnic differences really mean in terms of adolescents' mathematics achievement. How might researchers or educators use this information to explain the differences in adolescents' math achievement?

First, ethnic differences could mean cultural differences or differences in social systems. Cultural values shape an individual's perspectives of the world and permeate every aspect of daily life. Through education, people are taught how to act, how to communicate, and how to adapt to society, all of which are affected by culturally-based beliefs. Culture tells a person how to view the world, how to experience it emotionally, and how to behave in it in relation to other people (Helman, 1994). During the last decade an increasing number of researchers have examined culture from individualistic and collectivistic perspectives (Triandis, 1995). Traditionally, American culture is described as individualistic while Chinese culture is described as collectivistic (Markus & Kitayama, 1991). Individualism refers to the extent to which individuals view themselves as independent and suggests that individuals are motivated by their own preferences, goals, and rights. Alternatively, collectivism is defined as the extent to which individuals view themselves as inextricably connected to others with such individuals expressly motivated by the norms and values of their cultural or social group.

However, researchers have advised caution regarding the practice of suggesting that cultures are monotheistic, homogeneous entities devoid of individual variation (Harwood, et al., 2001). Oyserman and colleagues (2002) found that individualism and collectivism cannot be considered as opposing constructs. Rather, they appear to be statistically independent or orthogonal in nature. Hence, an individual does not necessarily have to be low in one dimension in order to be high in the other (Oyserman, Coon, & Kemmelmeier, 2002). These findings highlight that individualism and collectivism are multifaceted dimensions that may coexist within a given culture. As such, they may be useful in describing differences and similarities among ethnic groups as well as providing a meaningful way to explaining why American adolescents had different values on mathematics than Chinese adolescents.

Second, ethnic differences may be related to a different college recruiting system in China and America. In China, each 12th grade student must participate in the "National University Entrance Examinations" if they want to enroll in college. Mathematics is one of the most important subjects in that examination. Students' scores must be above a certain score which is calculated by computer based on other students' scores as well as the number of students that attend the examination and the number who apply to attend college that year. Students' total examination scores are the only measure used to decide whether adolescents' can attend college or not. In addition, university faculty members prefer to recruit students with high scores in their mathematics examinations. Thus, educators and parents in China challenge their students to spend more time studying mathematics and to work hard. This may explain why Chinese students consider their mathematics achievement as extremely important and may be reflective of higher math achievement scores.

In addition to ethnic differences, there were some similarities between European-American and Mainland-Chinese adolescents in this study. For example, both groups of students reported similar beliefs about math anxiety and math attitudes and similar perceptions of parental math anxiety and math attitudes. The similarities might exist for several reasons. First, the Unites States sample comes from a rural community that has a large university and a large engineering firm. Additionally, 53% of students reported that their parents hold a graduate/professional degree and 39% stated their parents hold a college degree. This large number of college educated parents, coupled with the fact many are employed at the university and engineering firm may explain why this U.S. sample has more positive attitudes toward mathematics and less math anxiety compared to a typical European-American community or city. It may also explain why these U.S. students may look more like the Chinese sample.

Second, the American sample may have positive attitudes because the high school emphasizes math, parents may have positive attitudes towards mathematics, and the school is meeting standards set by the U.S. educational policy of "No Child Left Behind". While this U.S. sample of adolescents may be above average compared to other U.S. cities concerning their math achievement, overall mean scores for Americans are similar to the previous studies with similar reported measures. For example, in Hopko's (2003) study, the U.S. sample had similar math anxiety with the current European-American sample in this study. Using the Math Anxiety Rating Scale, Hopko, in a study of 815 students (749. 92% Caucasian) found the mean score for American adolescents was 33.25, which is reflective of the current sample mean 32.02. Similarly, Tapia and Marsh (2000) used the Attitudes Towards Mathematics Inventory in their study to measure 79 American high school students' math attitudes. They found a mean score of 35.34, which is lower than the current sample of 39.19. Other than these couple of studies, most researchers using these two measures reported means using different categorical variables, thus direct comparisons are not possible in a large generalizable sense.

In addition to the ethnic similarities and differences, researchers examined what factors predicted students' mathematics achievement, such as math anxiety and math attitudes (Ma, 1999; Robinson, 1975). However, researchers failed to provide consistent findings regarding the relationships between those factors and adolescents' math achievement. The second goal of the study was to examine adolescents' peers and parents' influence on their personal math achievement. I found that the prediction of adolescents' perceptions of peers was very strong. For example, peers' anxiety may account for 36% of variability of Mainland-Chinese adolescents' math anxiety, and may account for 25% of variability of European-American adolescents' math anxiety. Little is known about peers' influence in adolescents' mathematics learning in both European-American and Mainland-Chinese settings. However, in both groups, students spend much time in interaction with their peers. They learn together, they play together, and they make friends with each other. Schools may be considered as a small society which involves different individuals in a variety of daily activities and interactions. Adolescents communicate with their peers, and at the same time they learn from their peers. Thus, because of the significant time peers spend with each other, this may explain why peers' influence may be more important than parental influence.

It is interesting to find that for both ethnic groups, adolescents' perceptions of their own math anxiety negatively predicted their perceptions of math achievement, while Mainland-Chinese adolescents' perceptions of math attitudes did not predict their perceptions of their own math achievement. European-American adolescents' perceptions of parental and peers' math attitudes did not predict adolescents' math attitudes and math achievement. It appears that parents' or peers' math attitudes were not as important as the adolescents' own math attitudes on math achievement. One reason could be that individuals' attitudes may be different than their achievement. Individuals may feel very anxious about mathematics but still have positive math attitudes. Individuals who believe mathematics is not useful in their daily lives may still perform well in mathematics. For example, Mainland-Chinese students who want to attend college may be good at math although they feel the mathematics examinations are not practical, nor real-world oriented. But they are still trained to achieve high scores on those tests by their teachers and parents.

Taken together, different cultural beliefs, different educational systems, and different values students and their parents may have concerning mathematics achievement may explain the ethnic differences. In addition, the samples in this study may be different from typical

American adolescents, as the samples have large numbers of college educated parents. This may explain why the American sample may look more like the Chinese sample. Finally, I found that adolescents' peers' influences are strong and may predict adolescents' math achievement. Students spend so much time with their peers in and out of school that the impact of peers may be important in valuing math and math achievement. Another possible explanation is that these adolescents in China and U.S. in this study come from middle class backgrounds. Some researchers suggest that middle class expectations such as educational values may be the same across ethnic backgrounds (Kellogg, 1990).

## Limitations

There are a number of limitations that one should consider before drawing final conclusions from this study. First, this study is limited by nature of the convenience sample. All participants were not randomly selected. Thus it may be limited in generalizability However, because it was a normal distribution across DVs and IVs and the assumptions of parametric tests, the ability to use parametric procedures and interpretation is appropriate.

In terms of European-American adolescents, much of the sample is from college educated families in a rural college town. As a result of this context, adolescents' perception of their mathematics experience and perception of parenting processes in terms of mathematics may be different than individuals from urban or other rural areas in the United States. In terms of the Mainland-Chinese adolescents, most of them are from a very urban area, Chengdu, which is the biggest city in west China. The variation of the Chinese sample is greater than the American sample, especially for parents' highest education level. Chinese parents' highest education level is lower than the American parents in this study, although generally speaking, families in Chengdu have a higher degree of modernization. As a result, adolescents from European-

American families have different backgrounds compared to adolescents from Mainland-Chinese families. It is also possible that their socioeconomic status is different.

In addition, there are very large regional differences within Mainland China. Urban Chinese and rural Chinese parents' experiences are quite different. Many of the Western regions in China are very poor with some provinces not having access to electricity. In these really poor areas, adolescents do not have the same opportunities to learn mathematics as adolescents living in big cities and the facilities in their schools are very poor. People tend to be more traditional in lifestyles because they have fewer opportunities to leave their region and connect to new things. As a result, adolescents' perceptions in the current sample may be very different from other adolescents who live in other areas of China.

The second limitation is methodology. To explore the relations among adolescents' math anxiety and attitudes, their perceptions of their parents' and peers' mathematics anxiety and attitudes, and their mathematics achievement, the current study had adolescents' self-report measures on all of the constructs. One problem inherent in a self-report approach to measure individuals' perceptions of other people is that the estimation of the relationships between the variables being studied introduces errors. This may occur as a result of students' failure to adequately report their actual thinking or that their perceptions about peers and parents may be colored by their personal biases (Goodnow, 1995). Adolescents may report what they believe to be ideal views about mathematics, which may or may not strongly correlate with their perception of their parents and peers' true beliefs. Further, having adolescents respond to pre-determined lists of feelings about mathematics and behaviors in the process of learning mathematics may lead adolescents to report perceptions they do not have in real world or do not actually perceive, although these constructs do have solid reported validity and reliability in previous as well as the current study. Also, limitations exist in applying parametric statistics to non-parametric data, even though many of the assumptions have been met. Thus, these findings should be considered preliminary.

A second problem is shared method variance (Miller, 1987). While interpreting relationships based on adolescents' self-reported perceptions of their parents and peers' math anxiety and attitudes, the relationships between two measures are always stronger when a single source reports on both measures than relationships between measures originating from different sources. The relationships among adolescents' perceptions of their parents', peers' and their own math anxiety and math attitudes may be inflated or overestimated because all the information was collected by one adolescent in each group.

Third, it is important to note that people from different cultures may adopt different standards when evaluating themselves on subjective Likert scales (Greenholtz, 2002). Greenholtz suggests that comparing measures with subjective Likert–type response options makes the cultural difference stronger just because these two groups use different standards to complete the survey. It should be noted that European-American adolescents may understand the items differently from Mainland-Chinese adolescents. Moreover, since the data are correlational in nature, causal inferences about the relationships between variables should be viewed with caution.

In addition, adolescents' mathematics achievement was reported by students themselves. While perceptions may be accurate, they may not be as accurate as actual achievement measures. However, finding common achievement measures between the U.S. and China is difficult at best. Thus, findings related to adolescents' mathematics achievement should be interpreted with caution. Meanwhile, because Chinese adolescents brought questionnaires back home to complete, their parents may help them finish the survey. Parental influence could be strong in terms of Chinese sample.

## Future Directions

We may have learned several new directions for research from this study. First, in terms of studies of Chinese social science, special attention should be paid to population variation. Great differences have been suggested to exist in individuals' experiences in rural versus urban settings in countries around the world. For example, adolescents living in rural areas in China tend to have fewer opportunities to attend college than adolescents living in urban areas. Thus to attend college, they may have to spend more time and effort learning mathematics and practicing mathematics problems. These differences should be examined and studied in order to better understand how cultural values, economic opportunities and rural versus urban communities impact Chinese adolescents' experience of learning mathematics. While achievement scores between China and America appear different, perhaps the difference is not as great as reported if variations in geographic and education level are taken into account. Further, as a result of the sample used for the current study, the results cannot be generalized to a larger population. For future research, it is important that researchers randomly recruit a more diverse group of parents from various walks of life and from urban versus rural settings.

It should be noted that large variability exists between urban areas versus rural areas in Mainland China (Zimmer & Kwong, 2003). Differences include family size, family structure, relations between siblings, relatives and first-second generations. All of these factors may impact adolescents' attitudes and beliefs. For example, rural areas in China are more traditional than urban areas since their basic economic condition and quality of life preserves traditional work and gender roles. Meanwhile, individuals living in big cities have more opportunities to acknowledge and experience different cultural values, less traditional gender roles, and more modernized social systems than rural families. Clearly, additional research is needed to examine the relationships between rural and urban Chinese parents' cultural values, parenting beliefs and practices.

Second, it is important for researchers to measure cultural values in order to make sense and provide context for adolescents' math anxiety and attitudes. From this study we find that there is a substantial amount of variation in adolescents' math anxiety and math attitudes. It is unfortunate that at this time, data could only be collected through self-report measures. In the future, researchers should use multiple measures, including interviewing students, observation of math classrooms and direct achievement measures, in order to examine the relationships among cultural values and adolescents' experiences in mathematics.

Further, in order to understand adolescents' parents' and peers' math anxiety and attitudes toward mathematics, it would be better to survey adolescents' parents and peers rather than asking adolescents to report their perceptions of those individuals. In the future, researchers may glean more rich data by interviewing. Additionally, they may interview students about how their cultural values relate to mathematics, or what kind of role that culture plays in learning mathematics.

## Conclusions

Generally speaking, findings from this study support the notion that parents' and peers' math anxiety and attitudes toward mathematics provide an important source for adolescents' math anxiety, attitudes and math achievement. However, the results of this study are not completely consistent with previous studies in terms of higher anxiety, negative attitudes and lower achievement in European-American students. In addition, adolescents' perceptions of their parents and peers may be different from their parents' and peers' own beliefs and behaviors. The sample we chose from the European-American population may not be reflective of American adolescents as a whole. Their parents are from a small college town, have middle class backgrounds, hold college degrees, and adolescents generally report higher mathematics achievement. Given this, additional research is clearly needed to examine adolescents' math experiences in a broader context with the use of different methodology.

Essentially, the findings of this study should remind researchers, practitioners, and teachers who work with parents or families to be aware of the cultural influences on adolescents' and their parents and peers' beliefs and attitudes in terms of mathematics. This awareness will allow these individuals to be more culturally sensitive to families and more cognizant of the need to help adolescents develop successfully in math achievement. As one of the most important tasks of education is to help students achieve competence in a specific area, American educators should realize that those ethnic differences in math achievement could be due to many factors confounded together. At this point, few causal explanations exist as to mathematics achievement differences.

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# APPENDIX

## Appendix A

**Research Participants Consent Form**
Adolescents' Perception of Parents'& Peers' Attitudes toward Mathematics and Mathematics Anxiety
Washington State University
Department of Educational Leadership & Counseling Psychology

Researcher: Huihua He, Ph.D students in Department of Educational Leadership & Counseling Psychology, 509-332-2805, Email: huihua_h@mail.wsu.edu

Purpose of the study: This study is designed to explore the difference in adolescents' perception of parents' and peers' attitudes toward mathematics and mathematics anxiety between European-American and Mainland-Chinese families.

Procedure: Your principle has given permission for this study. Adolescent students are invited to participate in this study. If you and your child agree to participate, your child will be asked to complete a survey at their convenience. They need to bring the completed survey, the signed consent form and the assent form to their classroom teachers. The survey will ask questions about their perceptions of you and their peers' attitudes toward mathematics and mathematics anxiety. It will take about 15-30 minutes to complete the survey. There is no right or wrong answers to those questions.

Benefits: The information gathered in this study will help parents, teachers and researchers understand adolescents' perceptions of their parents' and peers' attitudes toward mathematics and mathematics anxiety from different cultural perspectives. With this information, researchers may have a better picture about why American students have poorer mathematics performance than Asian students.

Risks: There are few risks to you or your child if you agree to participate in this study. If any of the questions on the surveys make you uncomfortable, you may choose not to answer that question.

Voluntary nature of participation: Your participation in this study is entirely voluntary. You may decide at any point in time to stop participating without penalty.

Confidentiality: All information we collect from you will be kept strictly confidential. You will be assigned an ID number and your answers will be entered into a data file that contains only your ID number, not your name. In all reported results, your child's identity will remain anonymous.

**CONSENT STATEMENT:**

This study has been explained to me and my child. My child and I volunteer to take part in this research. I have had a chance to ask questions. If I have general questions about the research, I can ask the researchers listed above. If I have questions regarding my rights as a participant, I can call the WSU Institutional Review Board at (509)335-9661. This project has been reviewed and approved for human participation by the WSU IRB. I will receive a copy of this consent form.

| ____________________________ | ____________________________ | ______________ |
|---|---|---|
| Participant's Parent Signature | Full Name (please print) | Date |

**Appendix B**

**Research Participants Assent Form**
Adolescents' Perception of Parents'& Peers' Attitudes toward Mathematics and Mathematics Anxiety
Washington State University
Department of Educational Leadership & Counseling Psychology

Researcher: Huihua He, Ph.D students in Department of Educational Leadership & Counseling Psychology, 509-332-2805, Email: huihua_h@mail.wsu.edu

We are doing a research study about the difference in adolescents' perception of parents' and peers' attitudes toward mathematics and mathematics anxiety between European-American and Mainland-Chinese families. A research study is a way to learn more about people. If you decide that you want to be part of this study, you will be asked to complete a survey at your convenience and it will take about 15-30 minutes.

Your principle has given permission for this study. High school students are invited to participate in this study. If you agree to participate, you will be asked to complete a survey. You need to bring the completed survey, the signed consent form and the signed assent form to your classroom teachers. The survey will ask questions about your perceptions of your parents' and your peers' attitudes toward mathematics and mathematics anxiety. There is no right or wrong answers to those questions. There are few risks to you if you agree to participate in this study. If any of the questions on the surveys make you uncomfortable, you may choose not to answer that question.

The information gathered in this study will help parents; teachers and researchers understand adolescents' perceptions of their parents' and peers' attitudes toward mathematics and mathematics anxiety from different cultural perspectives. With this information, researchers may have a better picture about students' mathematics teaching and learning.

When we are finished with this study we will write a report about what was learned. This report will not include your name or that you were in the study.

You do not have to be in this study if you do not want to be. If you decide to stop after we begin, that's okay too.

This study has been reviewed and approved by the WSU Institutional Review Board (IRB). If you have questions about this study, please contact the researcher at 509-332-2805. If you have questions about your rights as a participant, please contact the WSU IRB at 509-335-9661.

If you decide you want to be in this study, please sign your name.

I, ________________________________, want to be in this research study.
(Print your name here)

__________________________________ ______________
(Sign your name here) (Date)

**Appendix C**

**Adolescents' Perception of Parents' and Peers' Math Anxiety and Math Attitudes Survey**

The purpose of this survey is to examine what adolescents feel about their parents' and peers' math anxiety and math attitudes between European-American and Mainland-Chinese families. The survey also includes adolescents' own math anxiety and math attitudes. It will take about 15-30 minutes to complete the survey. If your parents and you agree to participate in this study, please sign the consent form and assent form. Please return the completed survey and signed forms to your classroom teacher. Thanks for your participation!

## Background Information

**Which grade are you in?** ________________________

**What is your gender?** ☐ **Male** ☐ **Female**

**What is your Ethnicity?** ☐ **American Indian/Alaska Native** ☐ **Asian/Pacific Island**

☐ **African American** ☐ **Hispanic/Latino**

☐ **White**

**What is your parents' highest level of education?**

☐ **Some High School** ☐ **High School**

☐ **Some College** ☐ **College Degree**

☐ **Graduate/Professional (e.g. MA, Ph.D.)**

**Other (please specify)** _____________________

**Please rate your overall mathematics performance in a 1-5 scale, 1 = extremely low level and 5 = high level:**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| **(extremely low)** | | | | **(high)** |

## Adolescents' Math Anxiety and Math Attitudes Survey

Please read the following items and rate what **YOU** feel about mathematics anxiety. Circle **1** if you feel no anxiety and circle **5** if you feel high anxiety.

| | **No Anxiety** | | **Neutral** | | **High Anxiety** |
|---|---|---|---|---|---|
| **1. Looking through the pages in a math text** | 1 | 2 | 3 | 4 | 5 |
| **2. Having to use the tables in the back of a math book** | 1 | 2 | 3 | 4 | 5 |
| **3. Thinking about an upcoming math test one day before** | 1 | 2 | 3 | 4 | 5 |
| **4. Watching a teacher work an algebraic equation on the blackboard** | 1 | 2 | 3 | 4 | 5 |
| **5. Being told how to interpret probability statements** | 1 | 2 | 3 | 4 | 5 |
| **6. Picking up a math textbook to begin working on a homework assignment** | 1 | 2 | 3 | 4 | 5 |
| **7. Taking an examination in a math course** | 1 | 2 | 3 | 4 | 5 |
| **8. Reading and interpreting graphs or charts** | 1 | 2 | 3 | 4 | 5 |
| **9. Signing up for course in statistics** | 1 | 2 | 3 | 4 | 5 |
| **10. Waiting to get a math test returned in which you expected to do well** | 1 | 2 | 3 | 4 | 5 |
| **11. Being given a pop quiz in math class** | 1 | 2 | 3 | 4 | 5 |
| **12. Walking on campus and thinking about a math course** | 1 | 2 | 3 | 4 | 5 |

*(Please continue to next page)*

Please read the following items and rate what **YOU** feel about your mathematics attitudes. Circle **1** if you strongly disagree the statement and circle **5** if you strongly agree the statement.

| | Strongly Disagree | | Neutral | | Strongly Agree |
|---|---|---|---|---|---|
| **1. Mathematics is a very worthwhile and necessary subject.** | 1 | 2 | 3 | 4 | 5 |
| **2. I want to develop my mathematics skills.** | 1 | 2 | 3 | 4 | 5 |
| **3. Mathematics helps develop the mind and teaches a person to think.** | 1 | 2 | 3 | 4 | 5 |
| **4. Mathematics is important in everyday life.** | 1 | 2 | 3 | 4 | 5 |
| **5. Mathematics is one of most important subjects for people to study.** | 1 | 2 | 3 | 4 | 5 |
| **6. Mathematics courses would be very helpful no matter what I decide to study.** | 1 | 2 | 3 | 4 | 5 |
| **7. I can think of many ways that I use math outside of school.** | 1 | 2 | 3 | 4 | 5 |
| **8. Mathematics is dull and boring.** | 1 | 2 | 3 | 4 | 5 |
| **9. I think studying advanced mathematics is useful.** | 1 | 2 | 3 | 4 | 5 |
| **10. I believe studying math helps me with problem solving in other areas.** | 1 | 2 | 3 | 4 | 5 |

*(Please continue to next page)*

## Adolescents' Perception of Parents' Math Attitudes and Math Anxiety

Please read the following items and rate what **YOUR PARENTS'** math attitudes. Circle **1** if you strongly disagree the statement and circle **5** if you strongly agree the statement.

| | Strongly Disagree | | Neutral | | Strongly Agree |
|---|---|---|---|---|---|
| **1. My parents believe mathematics is a very worthwhile and necessary subject.** | 1 | 2 | 3 | 4 | 5 |
| **2. My parents believe it is useful to develop their mathematics skills.** | 1 | 2 | 3 | 4 | 5 |
| **3. My parents believe mathematics helps develop the mind and teaches a person to think.** | 1 | 2 | 3 | 4 | 5 |
| **4. My parents believe mathematics is important in everyday life.** | 1 | 2 | 3 | 4 | 5 |
| **5. My parents believe mathematics is one of most important subjects for people to study.** | 1 | 2 | 3 | 4 | 5 |
| **6. My parents believe mathematics courses would be very helpful no matter what they decide to do.** | 1 | 2 | 3 | 4 | 5 |
| **7. My parents believe they can think of many ways that they use math outside of school.** | 1 | 2 | 3 | 4 | 5 |
| **8. My parents believe mathematics is dull and boring.** | 1 | 2 | 3 | 4 | 5 |
| **9. My parents think studying advanced mathematics is useful.** | 1 | 2 | 3 | 4 | 5 |
| **10. My parents believe studying math helps me with problem solving in other areas.** | 1 | 2 | 3 | 4 | 5 |

*(Please continue to next page)*

Please read the following items and rate what **YOUR PARENTS**' mathematics anxiety. Circle **1** if you think they feel no anxiety and circle **5** if you think they feel high anxiety.

| | **No Anxiety** | | **Neutral** | | **High Anxiety** |
|---|---|---|---|---|---|
| **1. Looking through the pages in a math text** | 1 | 2 | 3 | 4 | 5 |
| **2. Having to use the tables in the back of a math book** | 1 | 2 | 3 | 4 | 5 |
| **3. Thinking about an upcoming math test one day before** | 1 | 2 | 3 | 4 | 5 |
| **4. Watching a teacher work an algebraic equation on the blackboard** | 1 | 2 | 3 | 4 | 5 |
| **5. Being told how to interpret probability statements** | 1 | 2 | 3 | 4 | 5 |
| **6. Picking up a math textbook to begin working on a homework assignment** | 1 | 2 | 3 | 4 | 5 |
| **7. Taking an examination in a math course** | 1 | 2 | 3 | 4 | 5 |
| **8. Reading and interpreting graphs or charts** | 1 | 2 | 3 | 4 | 5 |
| **9. Signing up for course in statistics** | 1 | 2 | 3 | 4 | 5 |
| **10. Waiting to get a math test returned in which you expected to do well** | 1 | 2 | 3 | 4 | 5 |
| **11. Being given a pop quiz in math class** | 1 | 2 | 3 | 4 | 5 |
| **12. Walking on campus and thinking about a math course** | 1 | 2 | 3 | 4 | 5 |

*(Please continue to next page)*

## Adolescents' Perception of Peers' Math Attitudes and Math Anxiety Survey

Please read the following items and rate what **YOUR FRIENDS'** math attitudes. Circle **1** if you strongly disagree the statement and circle **5** if you strongly agree the statement.

| | Strongly Disagree | | Neutral | | Strongly Agree |
|---|---|---|---|---|---|
| **1. My friends believe mathematics is a very worthwhile and necessary subject.** | 1 | 2 | 3 | 4 | 5 |
| **2. My friends believe it is useful to develop their mathematics skills.** | 1 | 2 | 3 | 4 | 5 |
| **3. My friends believe mathematics helps develop the mind and teaches a person to think.** | 1 | 2 | 3 | 4 | 5 |
| **4. My friends believe mathematics is important in everyday life.** | 1 | 2 | 3 | 4 | 5 |
| **5. My friends believe mathematics is one of most important subjects for people to study.** | 1 | 2 | 3 | 4 | 5 |
| **6. My friends believe mathematics courses would be very helpful no matter what they decide to do.** | 1 | 2 | 3 | 4 | 5 |
| **7. My friends believe they can think of many ways that they use math outside of school.** | 1 | 2 | 3 | 4 | 5 |
| **8. My friends believe mathematics is dull and boring.** | 1 | 2 | 3 | 4 | 5 |
| **9. My friends think studying advanced mathematics is useful.** | 1 | 2 | 3 | 4 | 5 |
| **10. My friends believe studying math helps me with problem solving in other areas.** | 1 | 2 | 3 | 4 | 5 |

*(Please continue to next page)*

Please read the following items and rate what you think **YOUR FRIENDS**' mathematics anxiety. Circle **1** if you think they feel no anxiety and circle **5** if you think they feel high anxiety.

| | No Anxiety | | Neutral | | High Anxiety |
|---|---|---|---|---|---|
| **1. Looking through the pages in a math text** | 1 | 2 | 3 | 4 | 5 |
| **2. Having to use the tables in the back of a math book** | 1 | 2 | 3 | 4 | 5 |
| **3. Thinking about an upcoming math test one day before** | 1 | 2 | 3 | 4 | 5 |
| **4. Watching a teacher work an algebraic equation on the blackboard** | 1 | 2 | 3 | 4 | 5 |
| **5. Being told how to interpret probability statements** | 1 | 2 | 3 | 4 | 5 |
| **6. Picking up a math textbook to begin working on a homework assignment** | 1 | 2 | 3 | 4 | 5 |
| **7. Taking an examination in a math course** | 1 | 2 | 3 | 4 | 5 |
| **8. Reading and interpreting graphs or charts** | 1 | 2 | 3 | 4 | 5 |
| **9. Signing up for course in statistics** | 1 | 2 | 3 | 4 | 5 |
| **10. Waiting to get a math test returned in which you expected to do well** | 1 | 2 | 3 | 4 | 5 |
| **11. Being given a pop quiz in math class** | 1 | 2 | 3 | 4 | 5 |
| **12. Walking on campus and thinking about a math course** | 1 | 2 | 3 | 4 | 5 |

## THANGS FOR YOUR PARTICIPATION!