1-1-2017

# The Interplay of Culture, Motivation, and Self: An Investigation of Math Achievement Gap Between Middle School Students in the US and Those in the Top-Performing Countries in East Asia

Isbah Ali Farzan

# THE INTERPLAY OF CULTURE, MOTIVATION, AND SELF: AN INVESTIGATION OF MATH ACHIEVEMENT GAP BETWEEN MIDDLE SCHOOL STUDENTS IN THE US AND THOSE IN THE TOP-PERFORMING COUNTRIES IN EAST ASIA

By

Isbah Ali Farzan

A Dissertation

Submitted in Partial Fulfillment of the

Requirements for the Degree of

Doctor of Philosophy

Major: Educational Psychology and Research

The University of Memphis

May 2018

## Abstract

Ali Farzan, Isbah. Ph.D. The University of Memphis. May 2018. The Interplay of Culture, Motivation, and Self: An Investigation of Math Achievement Gap Between Middle School Students in the US and Those in the Top-Performing Countries in East Asia. Co-Major Professors: Dr. Christian E. Mueller and Dr. Leigh M. Harrell-Williams.

The students in the US are positioned in the middle among the nations on the international tests of academic achievement. This moderate achievement is a matter of great concern as it reflects the output of the US education system, as well as the input, in terms of human resource, available to the market. One way of probing this moderate achievement is its comparison with the achievement of students from the top-performing countries. Much of this comparative research lacks a fully-developed, systematic, and theoretical explanation of causes, notably ignoring the influence of culture on achievement. It is within this context that the present study was conducted.

Taking a relativist position, I compared the middle school students in the US with those in the top-performing countries in East Asia by engaging a theoretical framework comprising motivation, self-concept, and culture. I used Eccles and Wigfield's model of expectancy-value theory of achievement motivation (Eccles, 1983, Eccles & Wigfield, 2002), Marsh's internal/external frame of reference for self-concept (1986), and Triandis' (1995) individualism/collectivism constructs of culture to find an explanation of the identified achievement gap.

I used a subset of TIMSS (Trends in International Mathematics and Science Study) 2015 data of 36,115 middle school students in Chinese Taipei (Taiwan), Hong Kong, Japan, Korea, Singapore, and the US. One-Way ANOVA test and structural equation modeling were used to look into peer achievement, science achievement, math

self-concept, intrinsic value and utility value of math and their influence on math achievement of students from two cultural groups.

The results inform that in the US, peer achievement links differently to self-concept and intrinsic value; self-concept and utility value have high mean values; and they associate to achievement weakly or negatively. Thus, middle school students in the US do not believe in competition with peers; their perceptions about themselves and about the usefulness of the domain are inflated; and who value math more, score low on math achievement test. These student characteristics contribute to the moderate math achievement of students in the US.

## Table of Contents

## List of Tables

## List of Figures

## Chapter One: Introduction

Moderate math achievement continues to plague U.S. students when compared on international tests of achievement; most often, scoring toward the middle of those comparisons. Conversely, students who come from East Asian countries, such as Japan, Chinese Taipei (Taiwan), Korea, and Singapore, are consistently the top performers. As we move further into the 21st century and as the marketplace becomes increasingly global, this trend is especially troublesome for those concerned with educating U.S. students. For example, increasingly, many researchers are focusing on factors that influence retention along the STEM (Science, Technology, Engineering, and Mathematics) education pipeline (e.g., Yu, 2012; Wang & Degol, 2013). On a broader scale, other researchers have also sought explanations for these persistent achievement differences. Not surprisingly, that research has examined a broad array of factors, including demographic (e.g., SES, Akyuz & Bilim, 2014), individual (e.g., motivation, Haichun, Haiyong & Ang, 2013), interpersonal (e.g., parent or teacher influences, Cogan, Schmidt & Wiley, 2001; Tosa, 2009) and broader contextual influences (e.g., school-level or district-level policies and practices, Chen, 2011; Kaya, 2009). Although findings from this research are informative to the problem, there remain important gaps nonetheless. First, there are some researchers who argue that demographic influences are omnipresent and thus too difficult to overcome. Second, there is a dearth of research exploring how the other three categories interact in their influence on these achievement gaps. And last, to date, much of this research has lacked a fully developed systematic theoretical explanation of causes, notably ignoring the role of culture in its influence on achievement processes. It is within this context that the present study was conducted.

As already discussed, the focus of the present study was to explore the broader cultural variations in individual, interpersonal and contextual influences on math achievement and subsequent achievement gaps in that achievement among middle school students from the US and from the top-performing East Asian countries of Chinese Taipei, Hong Kong, Japan, Korea, and Singapore. As such, the theoretical framework used in the present study drew from theories of culture, self-processes, achievement motivation, and their collective influence on math achievement. In this case, Triandis' (1995) individualism/collectivism conception of culture, Marsh' internal/external frame of reference for self-concept (1986), and Eccles and Wigfield's expectancy-value theory of achievement motivation (Eccles, 1983, Eccles & Wigfield, 2002) served as the main theories for analysis. Middle school students served as the main populations of interest because it is assumed that achievement, self-concept, and motivational processes are still developing during this time. In the following sections, a more detailed discussion of each of these theories is provided followed by a summary of how they fit together in the context of the present study, the main research questions, and the hypotheses. Prior to providing deeper discussion around the guiding theoretical framework, a more detailed discussion around the problem of moderate math achievement is given.

## Math Achievement Gap

Historically, math and language are considered as the essential school subjects to prepare individuals for effective participation in their society (Watermann & Klieme, 2002). To ensure students' ongoing preparedness for citizenship, higher education, and employment, international tests focus on measurement and comparison in these two subjects on an ongoing basis. International comparisons such as TIMSS (Trends in

International Mathematics and Science Study) and PISA (Programme for International Student Assessment) are gathering more attention in the 21st century with the blurred geographical boundaries in the global economy and virtual marketplace. As discussed already, the US ranks consistently in the middle of all nations when it comes to math achievement. Again, this becomes increasingly problematic as the US strives to remain globally competitive while striving to provide quality education to an increasingly diverse student population of students. It is for these reasons that researchers, educators, and policymakers alike are interested in exploring and resolving the key underlying causes of this ongoing moderate achievement.

Although some may argue that moderate academic achievement is a recent phenomenon, the US has assumed this position since the start of international tests in 1960. Upon further consideration, this achievement issue is manifest regardless of school level, gender, and subject matter. The achievement gap between these students and those from the top-performing countries increases as students progress along their educational path. The standing of the U.S. students in grade four is better than those in grade eight (Abu-Hilal, et al., 2014); simultaneously, the standing of students in grade 12 is better than those in Grade eight (Watermann & Klieme, 2002). Thus, over time, the competitiveness of U.S. students in math gets worse the further along in grade they progress. Further complicating this issue, achievement gap in math is wider on advanced math (Watermann & Klieme, 2002). As a result, the competitiveness of U.S. students for high-level international jobs is further reduced. Last, with one of the highest high school dropout rates in the world, U.S. students place at a further disadvantage for competitive jobs worldwide (Papanastasiou, 2000). Interestingly, here the data can be a little

misleading as many of these students do end up getting employed, however, these jobs are between 40% to 100% less-paid than jobs requiring a university degree. Collectively, these factors combine to paint a very bleak picture of the US education system in general, and perhaps more importantly for the present study, for the long-term viability of the US to produce highly skilled workers in the changing global economy. Increasingly, these factors will eventually lead to what Hilton (2008) refers to as a "barbell" economy with highly skilled, knowledge workers on top, and low-paid, service workers at the bottom.

Stable moderate achievement of U.S. students in math, as elaborated above, brings attention to a couple of glaring challenges facing the US education system, as well as shedding light on possible factors contributing to the ongoing achievement issue. First, the US has only recently offered a national curriculum. This is important with respect to the ongoing achievement issue in math because all top-performing countries offer a national curriculum. Second, the secondary school system in the US offers multiple programs, such as ones for the gifted, which is unlike most of the countries participating in TIMSS (Trends in International Mathematics and Science Study) that usually contain only a single program for all students. This is important because some research has shown that context can have an influence on fluctuating motivational and self-belief processes especially among adolescents (Mueller & Winsor, 2016), and especially among US adolescents (Salchegger, 2015). Third, the US is highest in its expenditure per student. This is important because despite this investment, the US remains in the middle tier. Fourth, the US is one of the countries with the lowest high school completion rates. This is important with the blurred geographical boundaries in the job market and high ratio of university graduates in other countries. So, as a result, U.S. students holding a

high school diploma or less will most likely not be considered for high level or highly skilled jobs. And last, fewer US high school students take math and science. This is despite the recent focus of the US government on increasing participation in STEM education. Although these factors may indeed contribute to the ongoing achievement issue, they may or may not impact student achievement directly. Therefore, focusing exclusively on demographic and socio-political factors may prove futile over time. Instead, as discussed previously, it may actually prove more fruitful to explore the impact of intrapersonal, interpersonal, and contextual factors on math achievement. The next section explores the impact of these factors on adolescents.

**Theoretical Framework of the Study**

Within the broader literature, *contextual, intrapersonal, and interpersonal* factors are assumed to play an important role in student achievement broadly, and math achievement specifically. Contextual variables constitute the setting in which an individual lives and performs activities, roles, and interpersonal relations (Bronfenburner, 1995). These variables, such as culture, school environment, and home environment contribute to achievement in general (House, 2008; Papanastasiou, 2000), and to math achievement in specific (Zhu & Leung, 2011). Intrapersonal variables are those rooted in an individual including beliefs, drives, traits, and other motivational forces (Bandura, 1978). These variables, such as perception of self, motivational beliefs, and interest are related to achievement in general (House & Telese, 2015), and to math achievement in particular (Choi, Choi, & McAninch, 2012; Eklof, 2007; Shen & Tam, 2008). Interpersonal variables are rooted in relationships with others. These variables, such as parental influence, peer achievement, and engagement with others influence achievement

in general (Urdan, Solek, Schoenfelder, 2007), and math achievement in particular (House, 2006; Ing, 2014; Kilic & Askin, 2013). These three sets of variables operate at different levels, as well as interact with each other in their contribution to student achievement.

In the present study, a combination of contextual, intrapersonal, and interpersonal variables were used to investigate achievement difference in math between students in the US and in the highest performing countries on TIMSS (Trends in International Mathematics and Science Study). The study conceptualized contextual influence through the role that culture plays in shaping motivation and self-processes, which in turn are assumed to have a direct influence on achievement (Hamamura & Heine, 2008a). Self-concept[1] and subjective task values were used to represent the intrapersonal influence on achievement. Self-concept consists of individual's self-perceptions (Shavelson, Hubner, & Stanton, 1976), and is shaped by using internal and external references (Marsh, 1986). Subjective task values refer to the perception about the worth of engaging with a task (Eccles, 1983; Eccles & Wigfield, 2002). Peer achievement is used to represent the interpersonal influence on achievement. Here, it is to be acknowledged that peer achievement was not assumed to have a relational influence; rather, it was to acknowledge its role in influencing the intrapersonal variables used in the study through social comparison processes (Marsh, 1986; Marsh, Trautwein, Lüdtke, & Köller, 2008). Findings from this literature led me to develop a framework that took into consideration the variables of culture, self-concept, motivation, and influence from peers to collectively explore how these factors potentially influence math achievement differences of the US

[1] The study used self-concept for mathematics, thus is specific to one domain.

middle school students with those in the top-performing countries. In the next few sections, I provide details of each component of the theoretical framework, followed by the details of the framework and research design.

### Culture.

Culture is the human-made part of the environment (Herskovits, 1948), which provides a symbolic meaning system to individuals. Individuals make this meaning through shared values, beliefs, and behavior (Kagitcibasi, 2000). This symbolic system leads to a set of principles for living to individuals in a culture. Thus, culture guides individuals' ways of living, ways of dealing with others, and ways of thinking (Triandis, 1995). To understand culture and its influence on individuals, Triandis views culture through the lens of social patterns or what he labels as cultural syndromes. These patterns are themes, which tie different elements of a culture together. Tightness/looseness (Pelto, 1968), complexity/simplicity (Tylor, 1924), and individualism/collectivism (Triandis, 1995) are the main patterns or syndromes under this definition. Tightness/looseness explains a culture in terms of individuals' freedom of thought and action; a tight culture requires individuals to exactly follow norms of the homogeneous culture while a loose culture offers multiple choices of norms to individuals with the freedom to reject all of these. For example, Iwasa (1990) found American adolescents with a dilemma between right to life and right to property while those in Japan only believed in life with dignity. Complexity/simplicity explains a culture based on the sub-cultures and sets of social interaction rules offered to its members. Western cultures with technological and social developments are considered complex while primitive cultures are considered simple. Simultaneously, individualism/collectivism categorizes a culture by tracing influences on

individuals as coming from others or from self. In collectivist societies, individuals are closely linked and follow group norms and group members. Meanwhile, in individualist societies, individuals are linked loosely and follow their own preferences, needs, goals, and analysis. For example, in China, parents keep close vigilance of their children in early age. They transfer cultural and family values and make the child practice those. In western cultures, parents believe in independence and self-actualization of their children. They encourage reliance on self for decision-making (Triandis, 2016). Thus, collectivist and individualist cultures offer different sources for making meaning to individuals in their symbolic meaning systems.

Culture influences individuals' relationships with others, their behavior, and their thinking (Triandis, 1995). Thus, culture acts as a contextual variable, impacting both interpersonal and intrapersonal factors in building a personality. For instance, in the US, with an individualist culture, individuals are comparatively free from social bond; they follow their own aspirations and judgments and consider self-interest and ability while setting goals. Moreover, individuals within this cultural frame of reference define success largely through self-defined achievement. In contrast, in some East Asian countries with a collectivist culture, individuals stay closer to the people around them, follow rules set by those in authority, and consider others while setting goals. In other words, success is defined largely by how it impacts or reflects on one’s group membership (i.e., family, friends). These cultural differences in attributes are shaped by cultural influence on interpersonal factors such as social behavior, as well as intrapersonal factors such as identity, emotions, cognition, motivation, attitude, and values (Markus & Kityama, 1991). For instance, within individualist cultures, motivation is self-driven, whereas,

within most collectivist cultures, motivation is other-driven. Individualists strive for being a successful person and for meeting their own aspirations and demands (Hamamura & Heine, 2008b). Their achievement motivation is ability-driven, and they make effort for a particular task largely if they believe that they have the required ability while collectivists strive to serve the community and meet social demands. Their achievement motivation is effort-driven, and they attempt even if they lack trust in their own ability. With these differences, achievement behavior of individualists is embedded in their belief in self as an independent entity while collectivists' belief in self is as part of a group. Further referring to self, individualists have flattering [2]self-concept due to their desire to be a successful person and due to self as the major source of feedback for their achievement. On the other hand, collectivists have comparatively realistic[3] self-concept due to close connection and constant feedback from others on their achievement (Triandis, 1995). With these differences in motivation and self-concept in individualistic and collectivist societies, the present study used individualist/collectivist construct as the cultural explanation of poor math achievement of students in the US as compared to those in East Asia.

**Motivation.**

Motivation is a psychological process influencing the selection, direction, and strength of behavior (Bergin, Ford, & Hess, 1993). With this effect, achievement motivation guides individual's achievement behavior such as choice, persistence, and

[2] Self-enhancement bias, with majority of individuals reporting themselves as above an average individual (Triandis, 1995).
[3] Individuals rating themselves accurately in relation to others (Triandis, 1995).

performance. To explain this influence, recent theories of achievement motivation explore the transition from motivation to behavior, need to work on a task, and the probability of success (Eccles, Wigfield, & Shiefele, 1998). Most of these theories respond to one of these three aspects, such as self-regulation theory (Zimmerman, 1989) is about the transition, while goal orientation theory (Elliot & McGregor, 2001) focuses on the need for achievement. While, Eccles and Wigfield's model of expectancy-value theory (Eccles, 1983; Eccles & Wigfield, 2002) responds to the probability of success, as well as need to work on a task. Therefore, comparatively, this theory reflects on more aspects of achievement behavior. Also, with multiple interpersonal, intrapersonal, and contextual factors in the framework, it provides a comprehensive understanding of the psychological process of motivation. With these advantages, the expectancy-value theory has been shown to explain achievement broadly (Guo, Parker, Marsh, & Morin, 2015) and math achievement specifically (Luttrell, et al., 2010). This demonstration has made it one of the main theories used in international achievement comparison studies (Eklöf, 2007). With these benefits of expectancy-value theory, I used it in the broader framework for the present study, which comprises of culture, motivation, and self-concept.

Eccles and Wigfield's model explains the motivation for achievement behavior by engaging social-psychological constructs. In this model, expectancies for success and subjective task values represent achievement motivation; these constructs are influenced by a set of interpersonal, intrapersonal, and contextual factors (Eccles, Wigfield, & Schiefele, 1998). This comprehensive framework, with independent and additive relationships, explains achievement behavior across domains, ages, and cultures. In the model, self-concept has a direct influence on both expectancies for success and subjective

values. This construct and other internal factors are guided by perceptions and interpretations, which are made in the environment. Culture, being part of the environment, plays a role in the development of expectancies and values.

Eccles and Wigfield's expectancy-value theory (EVT) is viewed as a good starting point to investigate the cultural influence on motivation and achievement (Wigfield, Tonks, & Klauda, 2009). However, they acknowledge that exploring the role of culture in the shaping of expectancy beliefs and subjective task values has been limited up to this point. They attribute this limitation to several factors, not least of which includes the use of definitions and theories of culture that do not lend themselves to an examination of internal and external processes. Realizing this limitation, Wigfield, Tonks, and Klauda (2009) identify individualism/collectivism as a way to reflect on the reported motivation differences in East and West. Simultaneously, EVT views self-beliefs as the major contributor to expectancy and values. These beliefs include goals, self-schema, and self-concept of one's abilities. The latter is taken from Shavalson's self-concept construct and is considered domain specific under EVT. It is built through self-evaluations such as how well an individual is in a domain as compared to other domains and peers. These comparisons bring the construct closer to the one used in Marsh's internal/external frame of reference (1986) with input from both internal and external comparisons to build an individual's ability perception. The present study used this common element as a bridge to link EVT with Marsh's model and with an internal focus in societies with individualism and external focus in societies with collectivism to build a broader framework with motivation, self, and culture.

**Self-concept.**

Self-concept is a cornerstone of social and emotional development (Hwang, 2015), thus, is an important educational outcome. Also, it is one of the significant contributors to academic achievement (Waschescio, 1998). Due to these characteristics, self-concept is in the attention of education policy-makers and has been used as a vehicle to address socially rooted inequalities in education (Hwang, 2015). Self-concept is defined as an individuals' perception of themselves, constructed through their experience in the environment (Shavelson, Hubner & Stanton, 1976). It is operationally defined as "the perception of ability in different areas or domains" (Shavelson & Bolus, 1982). This construct is important in the field of achievement motivation due to its reciprocal relationship with achievement (Skaalvik & Hagtvet, 1990) and its input in the psychological process of motivation. Therefore, self-concept is a vital component of recent theories of achievement motivation such as Attribution Theory (Weiner, 1985), Social Cognitive Theory (Bandura, 1986), Goal Orientation Theory (Elliot & McGregor, 2001) and Expectancy-Value Theory (Eccles, 1983; Eccles & Wigfield, 2002).

Self-concept is built through self-evaluation of actions taking place in situations. Culture provides a reference point for making internal and external valuations through social comparison processes (Marsh, Trautwein, Ludke, Baumert, & Koller, 2007). For instance, Huguet, Dumas, Monteil, and Genestoux (2001) found Norwegian adolescents comparing themselves with peers having better academic achievement. This finding is grounded in high self-evaluation and the desire to look upward in the West as compared to low self-evaluation and face-saving behavior in the East (Hamamura & Heine, 2008b). Thus, comparisons, self-evaluation patterns, behaviors, and actions, which built self-

concept, are grounded in cultural practices. The role of culture in self-concept could have explored in the Internal/External Frame of Reference by Marsh (1986) as this frame incorporates external contribution in terms of peer achievement and internal contribution in terms of achievement and self-concept in another domain. However, cross-cultural studies using this frame take a universalist position by looking for generalizability of the model (Valentine, DuBois, & Cooper, 2004) and attempt to provide evidence that both internal and external frames of reference work in every culture. The present study took the relativist position to consider the comparative strength of these references of self-concept in the US and the East Asian countries.

**The Present Study**

The present study investigated moderate math achievement of middle school students in the US by comparing it with that of students in high performing East Asian countries. For this investigation, the study used a comprehensive framework with intrapersonal, interpersonal, and contextual variables representing motivation, self, and culture (Figure 3). Students in the US are reported to have high motivation, which is weakly correlated with academic achievement, in comparison to the students in East Asia. Secondly, the US has an individualist culture while East Asia has a collectivist culture. I proposed the second finding as an explanation for the established motivation trends. These two pieces were knitted together through internal/external frame of reference for self-concept (Marsh, 1986). The present study engaged the (a) expectancy-value theory (Eccles, 1983; Eccles and Wigfield, 2002) for motivation, (b) internal/external frame of reference (Marsh, 1986) for self-concept, and (c) individualism/collectivism (Triandis, 1995) for culture. The relativist position aimed to

identify cultural differences in self-concept and motivation to respond to the following research questions:

1. Does the proposed framework with motivation, self-concept, and culture explain moderate math achievement of middle school students in the US in comparison to those in the top-performing East Asian countries?
    1.1. Do achievement motivation and self-concept vary for students in the US from those in the East Asia countries?
        1.1.1. Do students in the US have a high mean value of self-concept than those in the East Asia countries?
        1.1.2. Do students in the US have a high mean value of intrinsic value than those in the East Asia countries?
        1.1.3. Do students in the US have a high mean value of utility value than those in the East Asia countries?
        1.1.4. Do students in the US have a weak relationship between self-concept and math achievement than those in the East Asia countries?
        1.1.5. Do students in the US have a weak relationship between intrinsic value and math achievement than those in the East Asia countries?
        1.1.6. Do students in the US have a weak relationship between utility value and math achievement than those in the East Asia countries?
    1.2. Do students in the US focus on internal reference while those in East Asia on external reference for self-concept and intrinsic value?
        1.2.1. Do students in the US have a stronger relationship between science achievement and math self-concept than those in the East Asian countries?

1.2.2. Do students in the US have a strong relationship between science achievement and math intrinsic value than those in the East Asian countries?

1.2.3. Do students in the US have a weak relationship between peer math achievement and math self-concept than those in the East Asian countries?

1.2.4. Do students in the US have a weak relationship between peer math achievement and math intrinsic value than those in the East Asian countries?

1.3. Does individualism/collectivism serve as an explanation for the identified trends in motivation and self-concept?

These questions are answered by testing the hypotheses as follows:

1.1.1. Ho: Students in the US have a significantly high mean value of self-concept than those in the East Asian countries.

1.1.2. Ho: Students in the US have a significantly high mean value of intrinsic value than those in the East Asian countries.

1.1.3. Ho: Students in the US have a significantly high mean value of utility value than those in the East Asian countries.

1.1.4. Ho: Students in the US have a significantly weak relationship between self-concept and math achievement than those in the East Asian countries.

1.1.5. Ho: Students in the US have a significantly weak relationship between intrinsic value and math achievement than those in the East Asian countries.

1.1.6. Ho: Students in the US have a significantly weak relationship between utility value and math achievement than those in the East Asian countries.

1.2.1. Ho: Students in the US have a significantly stronger relationship between science achievement and math self-concept than those in the East Asian countries.

1.2.2. Ho: Students in the US have a significantly strong relationship between science achievement and math intrinsic value than those in the East Asian countries.

1.2.3. Ho: Students in the US have a significantly weak relationship between peer math achievement and math self-concept than those in the East Asian countries.

1.2.4. Ho: Students in the US have a significantly weak relationship between peer math achievement and math intrinsic value than those in the East Asian countries.

1.3. Ho: Individualism/collectivism serves as an explanation for the identified trends in motivation and self-concept.

The present study comprised of five chapters. These hypotheses were tested using TIMSS (Trends in International Mathematics and Science Study) 2015 dataset for mathematics. I used One-Way ANOVA and structural equation model (*SEM*) to test the model (Figure 3) and the hypotheses. After testing the overall model of *SEM*, I used multiple group modeling to measure the difference in self-concept and motivation between the students in the US and those in East Asia to respond to the research questions.

With this investigation, I attempted to discover the interplay of intrapersonal, interpersonal, and contextual factors in their contribution to the achievement gap between

students in the US and those in the top-performing countries. With a framework engaging theories of self, motivation, and culture, I aimed to provide a systemic theoretical explanation of causes of moderate math achievement of middle school students in the US. This explanation was expected to support the efforts to understand U.S. students' achievement motivation, thus, to route a way for improving moderate math achievement.

# Chapter Two: Literature Review

## Overview

Chapter Two is a review and synthesis of the literature fundamental to the goals and objectives of this study, with major contributions coming from the areas of culture, self-concept, and achievement motivation. As such, a brief review of these areas is provided, followed by a discussion of how these broad literatures fit together to inform the present study. As the framework used culture to explain the math achievement gap between middle school students in the US and those in East Asia, it is important to have a historical perspective of how this framework developed. After providing the problem statement, this chapter begins with a brief review of empirical research conducted in culture.

The present study was triggered by the consistently reported math achievement gap between middle school students in the US and those in the top-performing countries in East Asia. Moderate achievement of the U.S. students on international tests of academic achievement is a matter of great concern as it reflects the output of the US education system, as well as the input, in terms of human resource available to the market. This problem becomes more severe in the modern time when geographical boundaries of countries are blurring due to globalization. The position of the U.S. students in the middle of the nations, whereas the position of students from Korea, Japan, Chinese Taipei, Hong Kong, and Singapore from East Asia might get reflected in their ratio in attaining a higher educational degree. Higher education is a pre-requisite for high-level jobs (Patnam, 2014), thus the present moderate-ranking of the U.S. students can be seen as an indicator of fewer chances for them to reach to high-level jobs in future. Due

to the gravity of this issue, and the potential impact it may have on the ability to graduating U.S. students to be globally competitive in the marketplace, increasingly, moderate academic achievement of the U.S. students has become an area of focus for both government (e.g., National Science Foundation) and educational entities. For example, realizing the importance of this issue, the US government has recently emphasized STEM (Science, Technology, Engineering, and Mathematics) education in research-, policy-, and practice-oriented efforts. Similarly, researchers are also engaged with examining this achievement gap, and have investigated such issues as shortcomings in the education system (teacher input in Pitchford, 2014; Tosa, 2009; school leadership in Kraft, Marinell, & Shen-Wei Yee, 2016) and psychological and motivational issues with the students (e.g., Ker, 2016; Yu, 2012). Broadly, findings from these investigations have shown that many factors contribute to this gap, including demographic, contextual, intrapersonal, and interpersonal factors. As discussed in Chapter One, there are many limitations to this existing body of research including a lack of an integrated and systematic theoretical framework, which makes it difficult to inform the issue on a broader scale (e.g., Ceylan & Akerson, 2017; House, 2009). It is within this context that the present study was conducted.

While considering the achievement gap between the students in the US and those in East Asia, culture comes forth as an obvious difference in these two populations. The US belongs to the western world while the countries in East Asia share the Confucius culture. Culture structures and informs the way people think and act (Triandis, 2011), thus this obvious difference in these two student populations could be expected to lead to differences in achievement-related behaviors, processes, and eventually outcomes.

Interestingly, this aspect has not been explored fully in research on achievement gaps in East and West (Chiu, 2008). Realizing this gap, the present study intended to relate culture with the ways students think about achievement, self, and others. Thus, it proposed a theoretical framework comprising broader contextual variables of culture, intrapersonal constructs of self-concept and achievement motivation, and an interpersonal variable of peer achievement. Each of these will be defined specifically later in the chapter. In particular, the theoretical framework engaged constructs from the individualism/collectivism construct model of culture (Triandis, 1995) (Individualism/Collectivism, *henceforth*), internal/external frame of reference for self-concept (Marsh, 1986) (I/E Model, *henceforth*), and Eccles and Wigfield's Model of expectancy-value theory (Eccles, 1983; Eccles & Wigfield, 2002) (EVT, *henceforth*) to investigate the math achievement gap between middle school students in the US and those in high-performing countries in East Asia.

**Section One: A Historical Perspective on the Study of Culture**

Cross-Cultural investigations are comparatively recent to the field of psychology despite their robustness in explaining differences and similarities across student cognition, motivation, and behavior. This delay in the realization was rooted in the early belief that humans drive culture, thus culture is "the human-made part of the environment" (Herskovits, 1948). World War II inspired psychologists to inquire why and how nations think and act differently (Segall, Lonner, & Berry, 1998) and many journals on cross-cultural psychology such as Cross-Cultural Psychology Bulletin and International Journal of Psychology started their publication in the 1960s and 1970s. Investigations in this field resulted in an evolution in cultural psychology. The stand on

"humans drive culture" was replaced by acknowledgment of culture as a contextual influence on individuals' cognition and behavior. The new agenda of cross-cultural research was to a) test the then-existing theories in many cultures, b) to discover new aspects of phenomena through this test, and c) to integrate the learned knowledge from other cultures into the existing theories (Berry & Dason, 1974). This agenda was implemented gradually.

In the initial stage of implementation of this agenda, psychologists tested their theories across nations with a universal *etic*[4] perspective and with the intent to validate existing theories on a broader level (Triandis, 2004). Later, the etic approach to find commonality was countered by an *emic*[5] approach, which was intended to explore psychological phenomena in local cultures. Or, the role of context was recognized at a more proximal level. These two approaches are also known as absolutist and relativist positions respectively.

Further investigations on cultural differences resulted in recognition of different cultural practices of thinking and behavior. These differences were explained using categories of *tight/loose* (Pelto, 1968), *simple/complex* (Tylor, 1924), and individualism/collectivism (Triandis, 1995). A culture is categorized as tight or loose based on the tolerance it offers to individuals for their deviation from social norms (Gelfand, et al., 2011). The tight/loose dichotomy is applied in research on differences in Muslim and Western cultures. A culture is categorized as simple or complex based on the number of classes in elements of the culture such as a number of relationships, languages,

[4] The etic view emphasizes that psychological processes are basically the same and have different manifestations (Triandis, 2000, pp.186)
[5] The emic view emphasizes that psychological processes take unique culture-specific forms (Triandis, 2000, pp.186)

and religion (Triandis, 1995). The simple/complex category is used more frequently for explaining differences in old and modern civilizations and in urban and rural cultures. Individualism/Collectivism classifies a culture based on individual- or group-oriented thinking and behavior of individuals (Triandis & Gelfand, 2012). Individualism/Collectivism is used to explain the difference between East and West (Moriizumi, 2011). The individualism/collectivism conception has been adapted and applied across many areas in addition to psychology (e.g., linguistics in Lun, Fischer, & Ward, 2010; health in Harkness & Keefer, 2000).

Of importance for the present study, historically cross-cultural empirical studies have consistently shown an East/West divide in individuals' motivation and cognition (i.e., Hughes, 2011; Hsu, 1972; Sawada, 1996). This reporting was strengthened by Hofstede's (1984) book titled as "Culture's consequences: International differences in work-related values". Hofstede introduced social patterns of individualism and collectivism and found most of the countries in the West practicing individualism while those in the East practiced collectivism. Secondly, the author defined culture as the way people think communally. The first development endorsed the reported East/West divide and the second development facilitated explanation of that divide by linking context with intrapersonal attributes of individuals. To combine both developments, culture, as represented by East/West, influences human ways of thinking and acting.

Triandis (1995) used Hofstede (1984)'s categories in his *cultural constructs model* and explained how culture and self-concept work together differently in the East being collectivist, and the West being individualist. Coming full circle, Markus and Kitayama (1992) used developments by Hofstede and Triandis to synthesize previous

work in psychology and identified East/West divide in cognition, emotion, and motivation. Out of this realization, Markus and Kitayama, among others (e.g., Pcibasi & Poortinga, 2000), have criticized some research in this area as being overly reliant on a western paradigm to understand ways of thinking and behaving. Since then, researchers have dramatically increased attention to the cultural influence on self-concept as Triandis (2004) reported a seven-fold increase in papers on cultural psychology from 1984 to 2000. This increase in the investigation has resulted in developments in social psychology such as identification of the use of *approach motivation* in the West while *avoidance motivation* in the East, and preference for *self-enhancement* strategies in the West and *face-saving* strategies in the East (Hamamura & Heine, 2008 a, b). However, these advances in social psychology are not reflected in much of the research on achievement motivation.

**Triandis' cultural construct model.**

Going back to Triandis' (1995) cultural construct model, it presents culture as shared beliefs, attitudes, norms, roles, and values. Use of one language, sharing of one geographical area, and living in the same historical period facilitate this sharing among the group members. These common beliefs, attitudes etc. are organized around a theme. The theme in individualist culture is that individuals are autonomous, while the theme in collectivist culture is that an individual is an integral part of the group. Elaborating these themes, individualism is the social pattern of loosely-knitted individuals who consider themselves as independent from others, behave as per self-defined rules and responsibilities, and pursue their own goals. In collectivism, an individual considers his or her collective group while making those decisions and while acting on them. These

differences in thoughts and actions influence cognition, emotion, and motivation. Thus culture, as a contextual variable, influences individuals' intrapersonal attributes and interpersonal relationship with other group members.

Under the Triandis (1995) model, family is the most important institute in the transfer of culture, in general, and specifically in the transfer of social patterns of individualism/collectivism. Parents provide the first exposure to attitudes, norms, and roles to the child thus setting his or her beliefs and values. In individualist cultures, parents respect the independence of the child thus children encounter fewer rules, lowered expectations to follow those rules, and the liberty to leave the family early. Childrearing with these attributes and expectations ends-up in a self-concept, which is independent and self-reliant. Conversely, in collectivist cultures, parents believe in dependence of the child thus children come across many rules, higher expectations to follow those rules, and the desire for them to stay with the family. Childrearing with these attributes and expectations ends-up in a self-concept, which is dependent and is attached to the group.

**Culture, self-concept, and motivation.**

Individualist/Collectivist societies' differences in family expectations and beliefs about self are mirrored in other institutions which contribute to the development of individuals, such as school and religion. The cumulative effect of these shared expectations and beliefs of institutes is an independent self-concept in individualist societies as against a dependent self-concept in collectivist societies. Individualists consider their own selves while setting goals, performing actions, and evaluating their achievement. Thus, they rely less on comparing themselves with other people or with a

general standard set in the society. As a result, this may lead to higher self-perceptions which include inflated estimates about one's ability (Triandis, 1995). On the contrary, collectivists look toward the group and its members while going through these self-evaluative processes. As a result, these individuals are reported with more realistic self-perceptions with modest estimates of self-concept (Hamamura & Heine, 2008a). The present study applies this individualism/collectivism difference in perception of general self-concept to the domain-specific self-concept. It assumes that in individualist culture of the US, students a) use the internal standard of achievement in science while constructing math self-concept, and b) have a flattering math self-concept. And, in collectivist cultures in East Asia, students a) use the external standard of peer achievement in the construction of math self-concept, and b) have a modest math self-concept.

The individualism/collectivism difference in individuals' self-concept continues in their motivation. Triandis (1995) assumed that with a flattered self, individualists overestimate themselves, and as a result have higher levels of motivation. Empirical research on achievement motivation reports individualists with a high level of achievement motivation and with the comparatively weak relationship between motivation and achievement (i.e., Liou, 2017; Stevenson, et al., 1990) thus endorses Triandis' assumption. Triandis also assumed that being realistic, collectivists do not over-estimate themselves and maintain a moderate level of motivation. Research on achievement motivation report individuals in collectivist societies with a modest level of motivation and with a strong relationship between motivation and achievement (Schütte, 2015; Zhu & Leung, 2011). The assumed realism of these individuals by Triandis might

be an explanation for collectivists' reported pattern of achievement motivation. I am interested if the present study repeats these contrasting findings with students from the US and from those in East Asia. Also, Triandis (2004) assumed that achievement motivation of collectivists is socially-driven while that of individualists is self-driven. The present study extended the internal and external standards for self-concept to the intrinsic value of Eccles and Wigfield's Model of Expectancy-Value Theory to test the impact of individualism/collectivism on achievement motivation. To sum up, a synthesis of developments in the field of culture informs of its impact on self-concept and motivation, thus there is a review of development in these fields in the next sections.

**Section Two: Self-Concept**

Perception about self has kept educational psychologists engaged since the start of the previous century due to its established position as a humanist outcome of education (Lee, Lee, & Bong, 2013), and a moderator for achievement motivation and behavior (Sarbin, 1952; Watts et al., 2015). Self-concept is the most frequently used construct related to self in educational psychology (Valentine, DuBios, & Cooper, 2004). It is grounded in "Me" self, introduced by James (1890). He explained it as the knowledge of self, comprising components such as knowledge of physical self and of academic abilities. In their groundbreaking work, Shavelson, Hubner, and Stanton (1976) defined self-concept as a person's perceptions of himself/herself. This definition led to the operational definition of the construct as "the perception of ability in different areas or domains" (Shavelson & Bolus, 1982). In another major development, Marsh (1986) explained the formation of self-concept in the I/E Model. This model explains self-concept in a domain by linking it with the external factor of peer achievement and an

internal factor of one's own achievement. This model has been validated across cultures, ages, and genders (Möller, Pohlmann, Köller, & Marsh, 2009).

### I/E Model.

Marsh acknowledges the contribution of intrapersonal attributes, in terms of achievement in another domain, and of the context, in terms of peer achievement, in an individual's self-concept. In this way, there is an agreement between Triandis (1995) and Marsh on the appreciation of both internal and external precursors of self. However, Triandis links strength of this contribution to the type of culture and highlights differences in the internally-driven self-concept in individualist societies and the externally-driven self-concept in collectivist societies (Triandis, 2011). As compared to this, Marsh considers both internal/external factors working together in their contribution. Up to this point, average peer achievement is the only identified contextual source of variation in the contribution of internal and external factors in self-concept (i.e., Mueller & Winsor, 2016). The present study aligned Triandis' Cultural Construct Model with Marsh's I/E Model by comparing the strength of contribution of internal and external references in math self-concept of students in the individualist society of the US with that of the students living in collectivist societies in East Asia. Understanding this the comparison provides a cultural explanation for math achievement gap between the two populations.

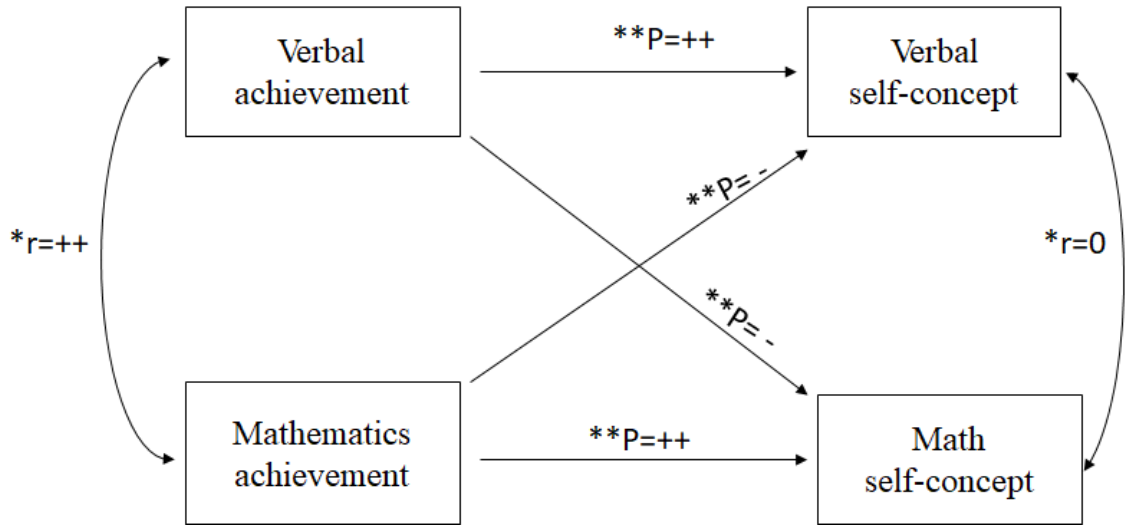


Figure 1. *Marsh (1986)'s Internal/External Frame of Reference Model*

*r=correlation, **p=prediction, ++= substantive and positive, - =small and negative. Taken from Marsh, H. W. (1986). Verbal and math self-concepts: An internal/external frame of reference model. *American Educational Research Journal, 23*(1), p. 134. Copyright 1986 by American Educational Research Association.

Under Marsh's I/E Model, individuals use academic achievement of peers as an external reference to compare their own achievement and feed this information to their self-concept. As a result of this comparison, an individual with average math achievement and below-average peer achievement is expected to have a high self-concept of math. An individual's academic achievement in different domains is usually positively correlated to each other, a positive correlation between math self-concept and verbal self-concept is expected (Marsh, 1986).

Besides the external reference, individuals use an internal reference of achievement in another domain to compare their achievement in the target domain and feed this information to their self-concept. Consequently, an individual with average math achievement and below-average verbal achievement is expected to have high math self-concept and low verbal self-concept (Marsh, 1986). Thus, internal referencing leads to negative inter-relationship between self-concept of two domains (Figure 1).

In this example, through external reference, math self-concept of an individual feeds positively to verbal self-concept. And through internal reference, math self-concept feeds negatively to verbal self-concept. These two comparisons cancel out each other; resulting in almost null correlation, which indicates no relationship, between math and verbal self-concept (Figure 1).

Marsh presented the I/E Model to explain consistent findings of a null correlation between math and verbal self-concepts. These findings challenged Shavelson, Hubner, and Stanton's (1976) claim of the multifaceted structure of self-concept. They defined self-concept as a domain-specific, multifaceted, and hierarchical construct. Math and verbal self-concepts belong to the category of academic self-concept and thus are expected to have a strong correlation with each other. This correlation may feed to academic self-concept, which is at the top of domain-specific self-concepts.

In contrast to this assumption, empirical studies have reported near-null correlation in math and verbal self-concepts (i.e., Byrne, 1984; Shavelson & Bolus, 1982). This finding was coupled with strong positive correlation in math and verbal achievement, and negative correlation of math achievement with verbal self-concept and vice-versa (Byrne, 1986). Collectively, these findings led to the development of the I/E Model. This model explains positive relationship through external referencing and negative relationship by internal referencing and defines the near-null relationship between math and verbal self-concept as a cumulative effect of both references.

After explaining the near-null relationship of math and verbal self-concept, the next challenge for I/E Model was to explain the reported positive relationship of self-concept in these two domains with other domains (i.e., Shavelson & Bolus, 1982). Marsh,

Kong, and Hau (2001) explained those positive relationships by elaborating contrast and assimilation processes involved in I/E referencing. In external referencing, contrast effect occurs when students choose peers for comparisons who they consider as not similar in achievement. The comparison with high-achievers decreases self-concept and that with low-achievers increases self-concept. The assimilation effect occurs when students choose peers for comparison who they consider similar in achievement. With this effect, comparison with high-achievers enhances self-concept of individuals as they consider themselves to be equally competent or with the potential to be of the same competence in future (Marsh, Trautwein, Ludke, Baumert, & Koller, 2007). In internal referencing, contrast process takes place when the standard domain carries contrasting characteristics from those of the target domain. In this process, comparison with high-achievement in the standard domain lowers self-concept in the target domain. Assimilation process takes place when standard domain carries similar characteristics to the target domain. This similarity strengthens self-concept in the target domain (Moller & Marsh, 2013).

Marsh, Byrne, and Shavelson (1988) elaborated the structure of academic self-concept. They proposed the arrangement of academic self-concept as a continuum of all academic domains. While elaborating this design, they defined math and verbal as two major domains, which are opposite in nature to each other, and which are positioned at the two ends of the academic domains' continuum. Based on this framework, math and verbal domains have a contrast relationship with each other. On the other hand, these domains offer assimilation process to the domains closer to them on the continuum such as math to science. This assimilation process has been found between math and physics, math and science, and among STEM (Science, Technology, Engineering, and Math)

subjects (Guo, Parker, Marsh, & Morin, 2015; Möller, Streblow, Pohlmann, & Köller, 2006; Parker, Marsh, Ciarrochi, Marshall, & Abduljabbar, 2017). Based on these recent findings, the present study used science achievement of the individual as an internal standard for math self-concept (Figure 3). Selection of science for comparison was based on assimilation process hypothesis that science achievement provides positive input to math self-concept. The finding was expected to provide an understanding of how self-concepts of STEM domains operate in relation to each other.

### *I/E Model and culture.*

The present study used self-concept as a link between motivation and culture in the theoretical framework. This connection was made based on the well-established link of self-concept with culture and motivation (Triandis, 1995). It is interesting that while exploring predictors of self-concept, studies using the I/E Model typically ignore cultural differences in those predictions. One obvious reason for this overlook is that most of the research is done in the West. The meta-analysis by Valentine, DuBois, and Cooper (2004) comprised 20 studies, and four of those were non-western. Similarly, the meta-analysis by Möller, Pohlmann, Köller, and Marsh (2009) used 69 studies and seven of them were from Asia. Marsh and Yeung (2001) recognized this overemphasis on the West and recommended for systematic cross-cultural comparisons.

The research done in the East is with the pursuit of supporting evidence for generalizability of the I/E Model. For instance, Xu, et al. (2013) tested the relationship among math, English, and Chinese language self-concept with grade seven students in Hong Kong. The results inform existence of assimilation processes between self-concept of the two languages and their contrasting relationship with math self-concept among

students from this Asian region. Marsh, Hau, and Kong (2002) tested the reciprocal relationship of achievement and self-concept for six years with high school students in Hong-Kong. The results provided supporting evidence for the relationship with no impact of the language of instruction (Chinese and English). Marsh, Kong, and Hau (2001) tested the relationship of self-concept and achievement in math, English, and Chinese with high school students in Hong Kong. The results inform that the relationship of achievement with self-concept in the same domain was positive while with self-concept in another domain was negative. With an etic approach to investigate, these researchers do not mention any deviation from the findings from the West.

One stream of studies tests I/E Model in both East and West. For instance, Marsh and Hau (2003) tested the big-fish-little-pond effect (BFLP) on academic self-concept with middle school students in 26 countries. The results of TIMSS data inform generalizability of negative effect of average school achievement on individual's self-concept. Moreover, in each of the 26 countries, the effect of individual achievement on academic self-concept was statistically significant but varied from .14 to .63. The authors did not explain this difference and presented the significance as an evidence for generalizability of the model.

With the etic approach, Chiu (2012) investigated an integrated framework of I/E Model and BFLPE) model with middle school students from 27 countries. Results of math and science data of TIMSS showed that the I/E Model and the BFLPE Model fitted data well, and the combined model fitted data even better. The model-fit was common to each of the countries in the sample.

With the recognition of individualism/collectivism divide of countries, Chiu (2008) tested contrast and assimilation processes in the I/E Model for math and science using TIMSS data of middle school students in 28 countries. They hypothesized more assimilation in four collectivist countries and more contrast in 10 individualist countries. The supporting evidence for the hypothesis was explained by the assumption that in collectivist societies, math and science domains are treated as relatively supplementary to each other and in the 10 individualist countries, they are treated as two different domains.

To sum-up, research on I/E Model in general, and cross-cultural research in particular, is done with the etic approach. However, Chiu (2008) shows the potential to explain the East/West divide in self-concept through individualism/collectivism. After exploring the connection of self-concept with culture, the next section of the chapter reviews research on integration of I/E Model with Eccles and Wigfield's Model of Expectancy-Value Theory (Eccles, 1983; Eccles & Wigfield, 2002) (EVT) as that was another piece of the theoretical framework in the present study.

### *I/E Model and motivation.*

There are recent attempts to combine the I/E Model with theories of motivation. These attempts are based on an understanding of self-concept as a moderator for achievement motivation and behavior (Sarbin, 1952; Watts et al, 2015). This understanding has resulted in the use of different constructs of self-concept in recent achievement motivation theories. For instance, self-concept of ability is the most powerful predictor of motivational variables of expectancy for success and subjective task values in EVT (Eccles, 1983).

In the EVT model, expectancy is the belief about the ability to work on a task and value is the belief about the importance of the task. These two constructs are predicted by intrapersonal factors such as self-concept, interpersonal factors such as other's perception about self, and contextual factors such as cultural stereotyping of the task. Under the influence of this broad array of factors, expectancy and value beliefs explain achievement behavior such as choice, persistence, and achievement (Figure 2). Therefore, EVT offers a link between self-concept and achievement with the mediation of these motivational constructs (Musu-Gillette, Wigfield, Harring, & Eccles, 2015), while the I/E Model also explains the relationship between achievement and self-concept. At the same time, both the models use Shavelson, Hubner, and Stanton (1976)'s definition of self-concept to defend self-concept.

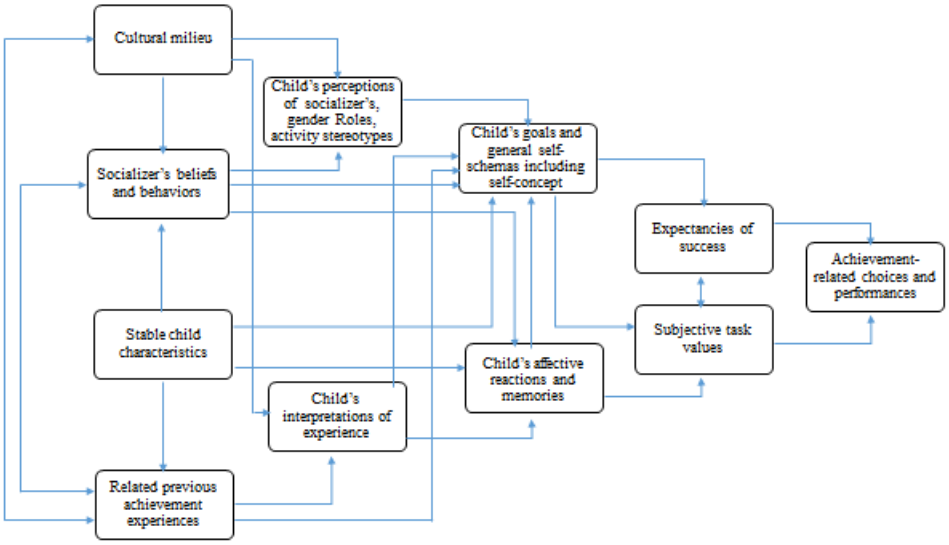


Figure 2. *Eccles and Wigfield's Model of Expectancy-Value Theory*

Taken from Eccles, J. S., Wigfield, A., & Schiefele, U. (1998). Motivation to succeed. In N. Eisenberg, W. Damon, & R. M. Lerner (Eds.), *Handbook of child psychology: Social, emotional, and personality development* (5th ed., Vol. 3, pp. 1017-1095). Hoboken, NJ, US: John Wiley & Sons Inc.. P. 52. Copyright 1998 by John Wiley & Sons Inc.

The agreement of the I/E Model and EVT on the definition of self-concept and on its relationship with achievement has resulted in efforts to integrate these models to investigate achievement motivation and behavior. Guo, Marsh, Parker, Morin, and Dicke (2017) tested a theoretical framework comprising EVT and the internal dimension of I/E Model with 18,047 grade eight students in Europe. They reported evidence for intra- and inter-domain relationship of the previous achievement with self-concept, intrinsic value, and utility, as suggested in the I/E Model, and impact of these psychological and motivational constructs on coursework aspirations, as suggested in EVT. Trautwein, Lüdtke, Marsh, Köller, and Baumert (2006) tested a theoretical framework integrating external reference of I/E Model with EVT by extending the influence of peer-achievement to interest value of EVT. The results of data of middle school students in Germany provide supporting evidence for an extension to this intrinsic motivation component of the value construct in EVT. Durik, Vida, and Eccles, (2006) tested internal reference of grade three achievement on constructs of self-concept, utility, and intrinsic value in grade four, based on I/E Model, and impact of these constructs on course choice and career aspirations in grade 10 and 12, based on EVT. Results of data from 606 participants in the US inform that the integration works, and a) previous achievement predicts ability and task beliefs, b) ability beliefs positively predicted all outcomes, c) utility predicted career aspirations and course choices, and d) intrinsic value predicted high school courses.

Guo, Parker, Marsh, and Morin (2015) tested the same assumption in STEM (Science, Technology, Engineering, and Math) subjects and provided supporting evidence for the combination of two models with Australian high school population. The

previous achievement was associated with self-concept and motivation beliefs, and both math self-concept and intrinsic value interacted in predicting advanced math course selection.

These successful attempts to integrate the I/E Model with EVT are due to the following: a) the use of self-concept in EVT as a predictor of motivational constructs, b) the agreement of both the models on the relationship of self-concept and achievement, and c) as it relates to the present study, the agreement of both the models on the impact of context on self-concept and motivation. In the I/E Model, external reference of peer achievement is the contextual variable, while in EVT culture is one of the predictors of self-concept and motivation (Figure 2). Empirical studies have identified the influence of this predictor on achievement and motivation gaps in the East and West; however, they have not engaged theories of culture to explain those gaps (i.e. Haichun, Haiyong & Ang, 2013; Zhu & Leung, 2011). Review of literature up till now, informs of the I/E Model's link with Triandis' cultural constructs model due to its use of both internal and external factors, as well as the alignment of the I/E Model with EVT due to self-concept and achievement relationship. Building on these links, the present study proposed a framework involving motivation, self, and culture to investigate math achievement gap between the middle school students in the US and those in high-achieving countries in East Asia. After elaborating culture and self, it is important to explore EVT as the last contributing piece of the theoretical framework of the present study. Besides a historical overview of EVT and discussion on its structure, the next section synthesizes research on East/West differences in motivation and self.

## Section Three: Historical Overview of Achievement Motivation

Like cross-cultural psychology and self-concept, recent theories of achievement motivation are grounded in theoretical and empirical shifts in the 1960s and 1970s. It was the time when psychologists moved their interest from external triggers of action in behaviorism to internal processes in cognitive psychology to explain achievement behavior (Graham & Weiner, 1996). During this gradual shift, investigations on drives and rewards (i.e., Marx, 1960; Spence, 1958) led to the realization of the involvement of internal decision-making in the stimulus-response process (i.e., Rotter, 1966). This comprehension resulted in a focus on internal attributes and processes in the newly-adopted cognitive approach to motivation (Eccles, Wigfield, & Schiefele, 1998). With this approach, recent theories of achievement motivation use self as a major predictor of motivation and achievement such as the use of self-efficacy in social-learning theory (Bandura, 1986) and self-concept of ability in Eccles and Wigfield's model of Expectancy-Value Theory (Eccles, 1983, Wigfield & Eccles, 2002a).

Another shift in the 1970s was in the testing of psychological constructs and theories through observation of non-humans in the laboratory (i.e., Hull, 1943; Lewin, 1935) to the observation of individuals in their environment (Graham & Weiner, 1996). This shift resulted in an appreciation of input from broader contextual variables, for instance, classroom environment, in achievement motivation and behavior such as in goal orientation theory (Elliot & McGregor, 2001) and attribution theory (Weiner, 1985). With these developments, recent theories of achievement motivation acknowledge the contribution of self and context in achievement motivation and behavior.

The growing attention to motivation theories to the inner processes led to their focus on the interrelationship among the intrapersonal determinants of achievement behavior. For instance, Atkinson's (1957, 1964) model of expectancy-value theory proposed the interplay of beliefs about personal needs and ability and about the task as the triggers for motivation. This model comprised three components of motivation; *motives*, the *probability of success*, and *incentive value of success*. According to Atkinson, the motive is the need for achievement, the probability of success represents expectancy for success or failure, and value represents the relative importance of success or failure. He proposed motivation for a task as a result of the inverse relationship ($1-P_s$) between the probability of success ($P_s$) and the incentive value (I). Atkinson inspired the later achievement motivation theorists like Feather (1988), Weiner (1985), and Eccles and Wigfield (Eccles, 1983; Wigfield & Eccles, 2002b) to use intrapersonal attributes in achievement motivation. In his theory, Atkinson highlighted the idea that motivation is caused by characteristics of an individual (probability of success), as well as of the task (intensive value of success). His theory triggered two of the three broad motivational questions which recent theories of achievement motivation attempt to respond: a) Can I do this task (probability)? b) Do I want to do this task and why (value)? and, c) What do I have to do to be successful in this task?

To respond to these questions, motivation theories and models propose that beliefs and cognitions trigger achievement behavior, and attempt to capture the psychological and interpretation processes involved in this prediction. For instance, Weiner (1985) discussed probability in his attribution theory. He posited that beliefs regarding ability, effort, task difficulty, and luck of previous tasks and outcomes guide

achievement behavior. These beliefs about a previous outcome lead to an interpretation of self and influence the performance on the task by establishing the probability of success. Following Weiner's discussion regarding probability, Elliot and McGregor (2001) discussed the motivational concept of value in their goal orientation theory. These researchers posit that value depends on whether an individual attempts to master or perform a task. This difference in the aim affects the way the individual perceives and performs a task. Similarly, Zimmerman (1989) responded to the question about the strategy for working on a task in his self-regulation theory. He proposed interplay of self-regulation strategies, belief of efficacy, and goals for working effectively on a task. Thus, recent theories of achievement motivation attempt to answer any one of the broad motivation questions.

In the effort to respond to the broad motivational questions, EVT is superior to contemporary theories of achievement motivation, as it answers the probability question in its construct of expectancy for success and to the value question in the construct of subjective task values. Both these motivational constructs are influenced by intrapersonal, interpersonal, and contextual variables (Figure 2). Thus, the model is comprehensive in terms of motivational constructs it uses, and in terms of the influences it captures on those constructs. Due to its comprehensiveness, the present study used this model in its theoretical framework to investigate the achievement gap between middle school students in the US and those in high achieving countries in East Asia.

### Eccles and Wigfield's model of Expectancy-Value Theory.

EVT explains achievement behavior including choice, persistence, and performance by using self-driven expectancy beliefs and task-driven *subjective task*

*values* (Eccles, 2005). These constructs are internal cognitive beliefs and are influenced by an individual's self and task perceptions, and by an individual's affective memories. As a result, these perceptions and affections are directed by perceptions about what others think of the individual and of the activity, and by individual's interpretation of previous achievement activities. These internal processes, thus, are driven by cultural practices, social behaviors, and the individual's stable characteristics (Wigfield & Cambria, 2010) (Figure 2). With this structure of the model, EVT anticipates the contribution of self-concept and culture in achievement motivation and behavior.

EVT is grounded in Atkinson's (1964) model of expectancy-value theory and can be traced back to departures from behaviorism by Tolman (1932) and Lewin (1935). In purposive behavior theory, Tolman proposed that an individual expects particular responses to certain stimuli, a term which he called purposive behavior. This alternative explanation of stimulus-response in behaviorism inspired expectancy for success construct in EVT, which is explained as individual's beliefs about their capacity to perform tasks successfully (Eccles, Wigfield, & Schiefele, 1998).

In field theory, Lewin (1935) proposed valance as relative attractiveness of the task. This concept is elaborated in subjective task values in EVT, which are individual's beliefs about the reasons to engage in the task (Eccles, Wigfield, & Schiefele, 1998). Eccles (1983) challenged Atkinson's suggested inverse relationship between probability of success and intensive value and proposed an additive relationship between these motivational constructs. Eccles and Wigfield enhanced these inputs from previous works by making expectancy and value broader and richer, and by adding contextual, intrapersonal, and interpersonal influences on these motivational constructs.

Going back to details of the EVT model, subjective task values respond to the question “Do I want to do this task and why?” (Eccles, Wigfield, & Schiefele, 1998). While forming the value of a task, an individual evaluates different aspects of the task in relation to personal ability, interest, and goals. This evaluation is subjective because different individuals assign different values to the same activity (Wigfield, Tonks, & Klauda, 2009). Also, this evaluation considers both positive and negative aspects of the task and is similar to cost-benefit analysis in which an individual looks into both the pros and cons of an activity (Wigfield, et al., 2015).

Eccles and Wigfield suggest four components of task values: intrinsic value, attainment value, utility value, and cost. Intrinsic value or interest is the capacity of the task to provide immediate enjoyment to the individual such as “How much do you like doing math?” This subjective value is an end in itself like intrinsic motivation by Harter (1986, 2012) and Deci and Ryan (1985). Similar to Deci and Ryan’s intrinsic motivation, high estimation of intrinsic value can lead an individual to deep engagement and persistence (Wigfield, Tonks, & Klauda, 2009). Attainment value is the personal importance of doing well on a task, such as "How important is it to you to get good grades in math?” This importance comes from the probability that the task will fulfill individual’s identity, power, and social needs. Attainment value is the capacity of the task to strengthen self, thus is an internally driven aspect of motivation. On the other hand, it is a means to an end, thus comes in the category of external motivation. Utility value is the capacity of the task to contribute to current or future goals such as " I think I will be able to use what I learn in this course in other courses". This value is similar to extrinsic motivation by Harter and by Deci and Ryan. Both these constructs are means to an end,

thus are extrinsic in nature (Wigfield & Cambria, 2010). On the continuum from internal to external motivation, intrinsic value is on the internal motivation end, attainment value comes in between, while utility value is on the external motivation end (Haichun, Haiyong, & Ang, 2013).

Cost is the estimation of the amount of effort, loss of time, and psychological meaning of failure, such as "Is the amount of effort it will take to do well in your math course this year worthwhile to you?" While estimating this value, an individual tries to identify the minimum effort to do a task. The individual makes this decision about the required amount of effort by comparing their ability with difficulty of the task. The individual also refers to other tasks and activities, which they need to give up for working on the selected task (Chow, Eccles, & Salmela-Aro, 2012).

The present study used intrinsic value and utility value to represent subjective task values in the theoretical model. These two values stand for an internal/external aspect of this motivational construct and have been used in cross-cultural studies to capture East/West difference in achievement motivation (i.e., Haichun, Haiyong, & Ang, 2013; Zhu & Leung, 2011;). The study used the I/E Model to align internal/external focus of individualism/collectivism with self-concept and motivation. However, intrinsic value and utility value may stand as an alternative tool for the investigation of an internal/external characteristic of East/West divide on motivation. Later in this section, the review of the literature on the use of these values to investigate East/West divide on motivation is expected to inform further.

Expectancy belief in EVT responds to the question "Can I do this task? (Eccles, Wigfield, & Schiefele, 1998) thus expectancy is a competency-belief about success on a

task or in a domain (Trautwein, et al., 2012). This construct comprises beliefs about expectancy for success such as "How well do you think you will do on your next math test?" or task-specific self-concept such as "How good at math are you?" and task difficulty concepts like "Compared to most of your other subjects, how difficult is math for you?" (Wigfield, Tonks, & Klauda, 2009). Thus, an individual builds expectancy for a task through evaluation of prospects of success on the task, his or her own ability, and difficulty level of the tasks. While making this evaluation, an individual assesses self and the task, and compares self in relation to peers to reach to a conclusion, such as "Compared to other students, how well do you expect to do in math this year?" (Muenks, Miele, & Wigfield, 2016). Thus, besides intrapersonal attributes, interpersonal factors contribute to the construction of expectancy beliefs.

***Self-concept and culture in EVT.***

Self-concept of one's ability is the most influential predictor of motivational constructs in EVT. It is the cognitive evaluation of ability to work on a task or in a domain such as, "I can do math." This description of the construct by Eccles and Wigfield is similar to the definition by Shavelson, Hubner, and Stanton (1976) of self-concept as an individual's domain-specific perceptions of him/herself.

In EVT, self-concept is directly linked to motivational constructs of expectancy and value, and through them, it is indirectly linked to achievement behavior. While introducing the model, Eccles (1983) acknowledged the importance of self-concept for achievement behavior, however, they mentioned mixed findings on strength of self-concept's influence on achievement. Eccles attributed those mixed results to lack of clarity on the causal direction of the relationship. Marsh (1986) brought that clarity in his

I/E Model by suggesting a reciprocal relationship between self-concept and achievement. The mixed results got further simplified by Marsh's elaboration that achievement in a contrasting domain reduces, while in a similar domain enhances, self-concept in the target domain (Marsh, Kong, & Hau, 2001).

On the one hand, self-concept predicts motivation and achievement, while on the other, it is influenced by cultural and social context (Dyson, 2015). The latter link is based on the assumption that an individual builds this perception of self while being part of the environment (Eccles, Wigfield, & Schiefele, 1998). Therefore, individuals are under the influence of others while they interpret their own attributes to form self-concept (Eccles, 1983). Also, individuals are under the influence of broader cultural beliefs and practices such as gender-role stereotypes while thinking about themselves (Wigfield, et al., 2015) (Figure 2). With these connections, self-concept links motivation with culture in EVT.

Self-concept construct in EVT is similar to the one used in the I/E Model in terms of its definition. Secondly, both the models agree on the relationship between achievement and self. Thirdly, EVT uses broader contextual variables including culture and intrapersonal variables including self-concept to predict achievement motivation. Similarly, the I/E Model presents an interpersonal relationship, in terms of peer achievement, and intrapersonal characteristic, in terms of self-concept of the standard domain, to predict self-concept. Building on common grounds such as these, many recent studies have successfully integrated these two models to investigate student achievement of different groups of ages, genders, and cultures (i.e., Yu, 2012). Based on these common grounds, the present study integrated both the EVT and I/E Model in the

theoretical framework. This integration was expected to facilitate investigation of the involvement of cultural practices in accounting for the achievement gap between students in the US and those in high-achieving countries in East Asia.

EVT presents self-concept as a mediator between achievement behavior and culture (Figure 2). The model acknowledges the influence of culture on self-concept and motivation using the construct of cultural milieu. This construct comprises gender role stereotypes, cultural stereotypes of subject matter and occupational characteristics, and family demographics. To elaborate, an individual decides about appropriacy of roles, tasks, domains, and occupations based on cultural beliefs and practices. This concept is endorsed by Triandis (1995) when he differentiates motivational practices in individualist cultures from those in collectivist cultures. Internal needs, rights, and capacities drive motives of individuals in an individualist culture, while needs and demands of others drive motives of individuals in a collectivist culture. As a result, achievement motivation of individualists is individually-oriented while that of collectivists is socially-oriented. While investigating this difference in these two types of culture, Yu and Yang (1994) found that socially oriented individuals prefer jobs, which provide family benefits. This finding validates Eccles and Wigfield's assumption of cultural stereotyping of domains and occupations.

In EVT, cultural milieu influences the way an individual thinks about others, roles, tasks, and self-concept (Eccles, 1983). Triandis elaborates the procedures involved in this influence by describing how cultural values and practices are transferred through family and other institutes involved in child rearing. In an individualist culture, parents expect independence and self-sufficiency from their child. They encourage decision-

making and self-reliance. These expectations and practices result in independent and self-oriented individuals. In a collectivist society, parents expect closeness and following of rules from their child. They practice closeness and punish the child for not following the social rules. These expectations and practices result in dependent and sociable individuals. With these differences in cultural orientation in individualist and collectivist societies a difference in cultural stereotyping is expected, leading to a difference in individual's perception about others, task, and self, and ultimately reaching to differences in achievement motivation.

### *Historical review of cross-cultural research on EVT.*

Earlier research on EVT was mostly about achievement gaps among gender groups (Eccles, 1983) age groups (Eccles & Wigfield, 1995) and on developmental changes in motivation (i.e., Eccles, et al., 1989; Eccles, & Wigfield, 1995; Eccles, Wigfield, Harold, & Blumenfeld, 1993; Meece, Wigfield, & Eccles, 1990). While reviewing empirical studies on EVT, Eccles, Wigfield, and Shiefele (1998) did mention findings on gender, age, and ethnic differences but not on cultural differences in motivation. Even those who have explored cultural differences have primarily focused on group differences within the US. Low achievement of African American students and comparatively high achievement of European American and Asian American students have been considered (i.e., Bempechat & Drago-Severson, 1999) and studies have been done on factors such as ethnicity and socioeconomic status (i.e., Mooney, & Thornton, 1999). This testing of EVT with samples in the West is reflective of the 20$^{th}$ Century trend of westernized psychological research (Markus & Kitayama, 2010).

In those times, the West stood as a standard for motivation beliefs thus studies conducted in East were looking for commonality, instead of differences, in both the cultures. For instance, James, Stigler, Smith, & Lian-wen Mao (1985) tested self-perception of ability in Chinese elementary school students. To understand the findings, they compared those with earlier findings from the US. They identified low competence beliefs in China but focused more on commonalities in the two samples. This etic approach, to find commonality in beliefs and practices, was common in psychological research of that time. While analyzing data from different cultures, researchers looked for evidence to validate theories (Triandis, 2004). This perspective was grounded in the belief that a good theory should be common across situations (Graham & Weiner, 1996). As a deviation to this trend, Hau, Kong, Marsh, and Cheng (2000) developed a Chinese version of SDQ (Self-Description Questionnaire) to test self-concept of Chinese students. By doing this, they acknowledged the difference of the western individualist way of thinking from the eastern collectivist way. However, following the trend, their study, with the etic approach, looked for generalizability of self-concept construct across cultures and reported similarities in self-concept of Chinese students with those in Australia.

As mentioned in the section on culture, Markus and Kitayama (1992) identified a trend in 20$^{th}$ Century research on the psychology of oversight to eastern thinking and behavior. Wigfield, Tonks, and Klauda (2009) found research on EVT following that trend. After appreciating the capacity of the model to measure cultural influence on achievement motivation and behavior, Wigfield et al. mentioned the dearth of studies on expectancy and value in the East. A handful of investigations on cross-cultural differences did report East/West differences in motivation level of students. However,

they did not tie the identified differences to variation in East/West cultures. Wigfield et al. recommended the use of individualism/collectivism to explain East/West cultural differences on motivation. They also recommended the addition of constructs in the model for cross-cultural investigation.

### *Empirical studies on East/West differences in motivation.*

Wigfield, Tonks, and Klauda (2009)'s identification of East/West differences in motivation level is elaborated by Ker (2017) who investigated the level of math self-concept, intrinsic value, and utility value, and change in this level from grade four to eight in China, Singapore, and the US. The U.S. students are reported with a higher level of self-concept but a lower level of values from the students in East Asia. Haichun, Haiyong, and Ang (2013) tested expectancy beliefs for physical education in middle school students in the US and China. The result informs a high level of expectancy belief in the US but a similar level of intrinsic value in both the countries. Randel, Stevenson, and Witruk (2000) investigated motivation and achievement of grade 11 students in Germany and Japan. The former are found with higher level of ability and interest value in math than the latter. Helmke and Tuyet (1999) tested the difference in intrinsic value and its link with learning strategies with university students in Germany and Vietnam. Asian students in Vietnam are reported with a high level of intrinsic value. To sum up, these studies validate the assumptions of Triandis' cultural construct model that being individualists, students in the West have high perceptions about themselves. However, the findings about values are mixed; Randel et al. and Ker found a higher level of values in the West, Helmke and Tuyet found a higher level of value in East, while Haichun et al. report similar level in both the cultures.

Value construct in EVT comprises of four components: intrinsic value, attainment value, utility value, and cost. While forming a single construct of subjective task value beliefs, these components are different from each other in some respects. For instance, intrinsic value is an end in itself while attainment and utility value are means to an end. Researchers take this attribute as a reason to classify intrinsic value as intrinsic motivation and utility value as extrinsic motivation in the model (Haichun, Haiyong, & Ang, 2013). This classification has been used in studies on East/West differences in motivation and achievement. For instance, by measuring intrinsic value, level of intrinsic motivation was reported the same in Haichun and Ker (2017) in East and West. While measuring attainment and utility value, level of extrinsic motivation was found the same in East and West in Haichun et al. and in Zhu and Leung (2011), but high in the West in Ker (2017). Further, for intrinsic motivation's relationship with achievement, Zhu and Leung (2011) and Wang and Gurthie (2004) found a significant positive relationship in both East and West while Ker found that only in East. For extrinsic motivation's relationship with achievement, Wang and Gurthie found it significantly negative in both East and West while Zhu and Leung found that in the West, and Ker identified it insignificant in the West. To sum up, these studies agree on the use of internal/external divide of values to explain achievement motivation differences in East and West but do not agree on how motivation is different in these two types of culture.

There are plenty of reasons for disagreement among these studies on East/West differences in the level of intrinsic and extrinsic motivation and on their relationship with achievement. First, motivation and achievement are domain specific (Graham & Weiner, 1996) and these studies vary in their selection of domain. For instance, Haichun,

Haiyong, and Ang (2013) tested motivation for physical education while Wang and Gurthie (2004) investigated motivation for reading.

Second, the criterion for a value to be intrinsic or extrinsic is its function as an end or a means to an end. The field of culture takes the West being internally-focused while the East being externally-focused in self-concept and motivation. However, Triandis (1995) defined external focus in terms of attention to people and practices around, and internal focus in terms of attention to personal goals, needs, and capacities. This conceptual difference in fields of culture and motivation is evident in the failure of motivational studies to use individualism and collectivism to explain East/West differences in values (i.e., Schütte, 2015; Zhu & Leung, 2011).

And lastly, this variance in findings on motivation in East/West can be due to measurement. All the studies mentioned above used TIMSS data thus used the same tools for measurement and sampling. However, these studies vary in their analysis and reporting. For instance, Ker (2017) distributed the sample in high and low motivation groups while Wang and Gurthie (2004) reported the mean level of motivation of students from different countries. Wang and Gurthie used separate structural equation model for samples from the US and China, while Ker used hierarchical equation modeling with countries and schools as the levels. These differences, among others, could have led to the unstable findings of motivational studies on East/West differences.

## The Present Study

The present study used motivation and achievement in mathematics. As discussed in Chapter One, the selection of the domain was due to its significance in academic and professional careers. Due to the importance, achievement gaps in this domain are a

constant attraction for research in general (i.e., Eccles, 1983; Hau, Kong, Marsh, & Cheng, 2000), and for cross-cultural research, in particular (Mooney & Thornton, 1999; Gustafsson, Nilsen, & Hansen, 2016). Math is one of the three domains regularly tested by international tests of achievement such as TIMSS and PISA, thus measures used in these studies for math motivation and achievement are well established. The present study used math motivation and achievement data collected by TIMSS in 2015.

Second, the study investigated moderate achievement of students in the US by comparing it with that of students from Korea, Japan, Chinese Taipei, Hong Kong, and Singapore. The countries selected for a comparison with the US had two features in common; they were the top-ranked countries in academic achievement since the start of the international tests of achievement in 1960s, also, they share East Asian culture. The first feature makes them a favorite normative group to investigate moderate national achievement (i.e., Stankov, 2010). The second feature facilitates the use of culture as a thread to knit findings from these countries. However, the present study measured the homogeneity of variance to ensure that students from these countries have a shared understanding of motivational items.

Third, based on the findings of the use of values to link motivation with the external and internal division in East/West, the present study used Triandis' definition of internal and external to see if students in the West look inward while constructing self-concept, and those in the East look towards peers.

Fourth, the present study used multigroup structural equation model to measure differences between students in the US and those in East Asia. This technique is frequently used in cross-cultural studies on motivation and self-concept to reach to

among-groups differences (i.e., Chiu, 2008; Marsh, et al., 2015). Details of the methodology are given in the next chapter.

This chapter has provided an overview of culture, self, and achievement motivation. This overview was aimed to identify common ground in Individualism/Collectivism by Triandis, I/E Model by Marsh (Figure 1), and EVT by Eccles and Wigfield (Figure 2). Building on those common grounds, the present study sought a cultural explanation of math achievement gap between middle school students in the US and those in high-achieving countries in East Asia. For this investigation, Chapter One introduced the research problem and research questions, Chapter Two has provided a rationale for the hypothesized theoretical framework, and Chapter Three provides a detailed discussion on the methods and procedures used in this investigation.

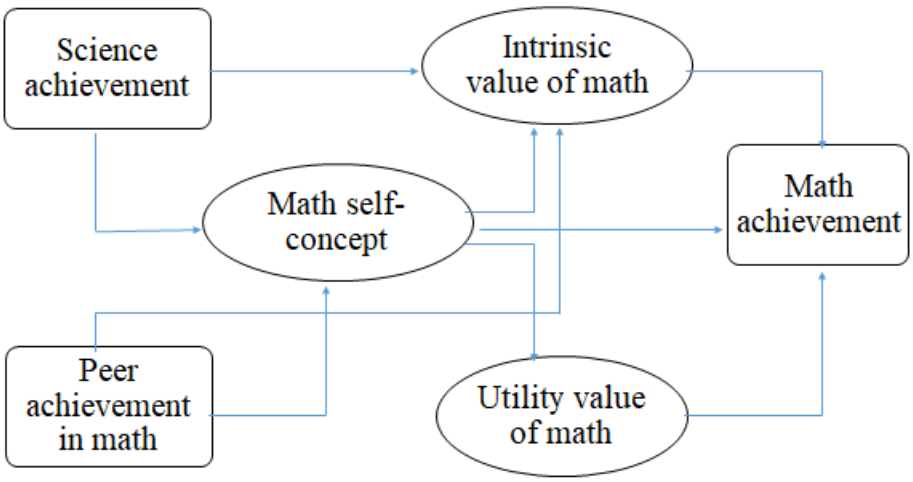


Figure 3. *Proposed Theoretical Framework*

Adopted from Eccles, J. S., Wigfield, A., & Schiefele, U. (1998). Motivation to succeed. In N. Eisenberg, W. Damon, R. M. Lerner (Eds.), *Handbook of child psychology: Social, emotional, and personality development* (5th ed., Vol. 3, pp. 1017-1095). Hoboken, NJ, US: John Wiley & Sons Inc. p. 52. Copyright 1998 by John Wiley & Sons Inc.

# Chapter Three: Methodology

The present study investigated an existing math achievement gap between middle school students in the US and those in the top-performing countries in East Asia. The theoretical framework guiding the present investigation drew from theories of achievement motivation, self-concept, and culture. In particular, the present study engaged constructs from Eccles and Wigfield's expectancy-value theory of achievement motivation (EVT, *hereafter*) (Eccles, 1983, Eccles & Wigfield, 2002), Marsh's internal/external frame of reference for self-concept (1986) (I/E Model, *hereafter*), and Triandis' (1995) individualism/collectivism cultural construct model to empirically assess this math achievement gap using the 2015 data of Trends in Mathematics and Science Study (TIMSS, *hereafter*) (Mullis, Martin, Foy, Hooper, 2016). The methodology chapter of the present study comprises five sections: (1) the original data source, (2) participant selection, (3) the theoretical model, (4) instrumentation, and (5) data analysis plan.

## Original Data Source

Data for the present study were derived from TIMSS, which has been conducted by the International Association for the Evaluation of Educational Achievement (IEA) every four years since 1995. These studies measure student achievement in grade four and grade eight in math and science across countries to capture comparative effects of education on student achievement. With the reporting of this measurement, TIMSS supports governments in making evidence-based decisions for improving education. To provide comprehensive reporting on student achievement, IEA also collects student, classroom, school, and home-related data. This contextual data includes information on

student motivation and self-concept (Provasnik, Malley, Stephens, Landeros, Perkins, &Tang, 2016). In 2015, more than 580,000 students from 57 countries and 7 benchmarking entities (regional jurisdictions of countries such as states or provinces) participated in TIMSS (Mullis, Martin, Foy, & Hooper, 2016).

To ensure national representation by the participating students, TIMSS utilizes a two-stage random sample design, with a sample of schools in a country drawn in the first stage, and one or more classes drawn in each of the sampled schools in the second stage. This sample design leads to approximately 150 to 200 schools and 4,000 students to participate in each grade and subject in every participating country. This random sampling at school and class level facilitates reporting by TIMSS on curriculum and instructional practices (LaRoche, Joncas, & Foy, 2016). However, the two-stage sampling leads to a complex structure of student sample data. TIMSS handles this complexity by using weights in data analysis (Joncas, 2008). While presenting data on student achievement, TIMSS provides student sampling weight: Total student weights - sums to the national population (TOTWGT, *hereafter*). Most of the studies use this weight to handle sampling error at student level (i.e., Chen, 2011; Zhu & Leung, 2011). For the same reason, the present study uses TOTWGT while examining the data to test the theoretical model.

Utilizing the sample design, TIMSS 2015 data were collected from March to May. Trained test administrators went into the sampled schools and administered 90-minute long achievement tests in math and science, they also administered a 30-minute long contextual questionnaire with students in the sampled class. Students responded to the test within the given time and with a break between two parts of the test. After the

test, they responded to the contextual questionnaire with the given or additional time. Teachers and principals of sampled schools responded to the questionnaires for them (Johansone, 2016). TIMSS & PIRLS International Study Center, the IEA Data Processing and Research Center, the IEA Secretariat, Statistics Canada, and National Research Coordinators developed standardized operations procedures for the test conduct, trained test administrators, and monitored the test conduct.

**Participant Selection**

The present study investigated moderate math achievement of middle school students in the US by comparing these students with those from high-achieving countries in East Asia. The average achievement of samples from Korea, Japan, Chinese Taipei, Hong Kong, and Singapore on TIMSS 2015 grade-eight math test is the highest among the 39 participating countries[6]. The average score of students from these countries is in the range of 621 to 586, while the average score of students in the US is 518 (Mullis, Martin, Foy, & Hooper, 2016). To make the comparison, the study used math achievement and contextual data of grade eight students from the US ($n$ = 10,221), and from Korea ($n$ = 5,309), Japan ($n$ = 4,745), Chinese Taipei ($n$ = 5,711), Hong Kong ($n$ = 4,155), and Singapore ($n$ = 6,116).

[6] TIMSS 2015 report cluster these five countries as high achievers while summarizing country-level student achievement in math (http://timssandpirls.bc.edu/timss2015/international-results/timss-2015/mathematics/student-achievement/). These five countries have been used in empirical studies for comparing low achievement of students in other countries (i.e., Yu, 2012; Zhu & Leung, 2011).

## Theoretical Model

The theoretical model used motivation constructs of intrinsic value and utility value, and self construct of self-concept to predict student achievement. Student achievement in science was the internal reference (as in Chiu, 2008; Marsh, et al., 2015), while peer achievement, or the average score of students in the school, was the external reference of self-concept and intrinsic value (Figure 3). Triandis proposes self to be under the greater influence of internal factors in the individualist cultures in the West, while under the influence of external factors in the collectivist cultures in the East (Triandis, 1995, 2016). Based on this distinction, I assumed that the students in the US have a stronger association of self-concept and intrinsic value with the internal reference, while students in East Asia have a stronger association with the external reference. This difference was expected to be used as an explanation for the established differences in motivation and achievement between students in the US and in the top-performing countries in East Asia (i.e., Haichun, Haiyong, & Ang, 2013; Ker, 2017; Mullis, Martin, Foy, & Hooper, 2016).

## Instrumentation

TIMSS has been measuring student's achievement motivation and self-concept with the student attitude scale since the first TIMSS study in 1995. This scale contains items on students' likening and value of math, and their confidence in math (Martin, et al., 2016). These items have been identified for their similarity with the constructs of intrinsic value, utility value in EVT, and self-concept in I/E Model (Elkof, 2007), and are used to measure these variables (i.e., Liou, 2017; Liou & Liu, 2015).

The student attitude scale, along with the rest of the contextual questionnaire by TIMSS, goes through a rigorous process of modification and pilot testing before each test cycle. This process takes in technical experts and statistical analysis of student response on items (Hooper, 2016). Because of this quality assurance, the scale for student attitude has been constantly modified and improved. For instance, instead of one scale for student attitudes in the early cycles of TIMSS, three independent scales on student likening, value, and confidence in the domain have been used since 2007. The number of items has increased from three items on one scale in 1995 to nine items on each of the three scales in 2015. Certain items have been discontinued after identifying poor student responses on them, for instance, "I would like to take more mathematics in school" and "When I do not understand a new math topic immediately, I know I will never understand" were used in TIMSS 2003 but have been discarded in the later studies. In 2015, TIMSS has introduced four new items in the scales for students' likening and students' confidence in the domain.

**Intrinsic value of math.**

The present study used intrinsic value of math as a motivation factor of math achievement based on the theoretical framework of EVT. Eccles and Wigfield define intrinsic value as the capacity of the task or domain to provide immediate enjoyment to students (Wigfield, Tonks, & Klauda, 2009). TIMSS 2015 included a 9-item Likert-Type scale to measure students' likening for math (Table 1). Conceptually, these items are consistent with the definition of intrinsic value variable of EVT. For instance, items "I enjoy learning math" and "I like to solve math problems" measure student engagement in math for pleasure. Consequently, the present study used these nine items to operationally

define middle school students' intrinsic value for math in the present study. Two items on TIMSS scale were negatively worded: "I wish I did not have to study math" and "Math is boring". All items on the scale were responded in the range from 1 (*agree a lot*) to 4 (*disagree a lot*). Except for the two negatively worded items, the items on the scale were reverse coded to use high scores as an indicator of the high intrinsic value of math.

Table 1. *Scales and Items Used in the Study.*

| Scale | Item |
|---|---|
| Self-concept | I usually do well in math. |
| | Math is more difficult for me than for many of my classmates*. |
| | Math is not one of my strengths*. |
| | I learn things quickly in math. |
| | Math makes me nervous*. |
| | I am good at working out difficult math problems. |
| | Math is harder for me than any other subject. |
| | Math makes me confused*. |
| | My teacher tells me that I am good at math. |
| Intrinsic value of math | I enjoy learning math. |
| | I wish I did not have to study math*. |
| | Math is boring*. |
| | I learn many interesting things in math. |
| | I like math. |
| | I like any schoolwork that involves numbers. |
| | I like to solve math problems. |
| | I look forward to math class. |

Table 1. (continued)

| Scale | Item |
|---|---|
| | Math is one of my favorite subjects. |
| Utility value of math | I think learning math will help me in my daily life. |
| | I need math to learn other school subjects. |
| | I need to do well in math to get into the University of my choice. |
| | I need to do well in math to get the job I want. |
| | I would like a job that involves using math. |
| | It is important to learn about math to get ahead in the world. |
| | Learning math will give me more job opportunities when I am an adult. |
| | My parents think that it is important that I do well in math. |
| | It is important to do well in math. |

Note. * = Negatively worded item
SOURCE: TIMSS 2015 Student Questionnaire grade 8. Copyright © 2013 International Association for the Evaluation of Educational Achievement (IEA). Publisher: TIMSS & PIRLS International Study Center, Lynch School of Education, Boston College.

Previous research has established evidence of psychometric properties associated with the likening for math scale used in TIMSS. Liou (2011) reported good internal consistency (Cronbach's alpha = .84) for the 4-item scale used in TIMSS 2007 for students in the US, Australia, Czech Republic, Chinese Taipei, Tunisia, Saudi Arabia, and Singapore. The item-total correlations were in the range of .61 to .80 and factor loading of items ranged from .76 to .90. Three out of four items in that scale were used in TIMSS 2015, which did not measure the item: "I would like to take more mathematics in school".

Marsh, et al. (2014) did their investigation on TIMSS 2007 data of grade eight male and female students in the US and Saudi Arabia. The 3-item scale of likening for math had high Cronbach's alpha in both countries (.86 in the US, .72 in Saudi Arabia). The scale has a correlation of .709 to .796 with confidence scale, and of .142 to .226 with math achievement. Conceptually, intrinsic motivation is closer to the construct of self-concept in comparison to the construct of student achievement. The high correlation of likening scale with confidence scale and low correlation with student achievement provide evidence for convergent and divergent validity to the likening scale. Two of those three items were measured in TIMSS 2015.

Choi, Choi, and McAnninch (2012) reported good internal consistency of 3-item TIMSS 2007 scale (Cronbach's alpha = .77 to .89) with students from eleven top-performing countries. These three items were used in TIMSS 2015.

**Utility value for math.**

Based on EVT, the present study used utility value for math as another motivation factor of math achievement. Eccles and Wigfield define it as the capacity of the task or the domain to contribute to current or future goals (Wigfield & Cambria, 2010). TIMSS 2015 included a 9-item Likert-Type scale to measure students' value for math (Table 1). Conceptually, these items are consistent with utility value in EVT. For instance, items "I think learning math will help me in my daily life" and "I need math to learn other subjects in school" measure student's value of math for current goals. Building on this consistency, the present study used these nine items to operationally define middle school students' utility value for math. All items on the scale were responded in the range from 1

(*agree a lot*) to 4 (*disagree a lot*). The items on the scale were reverse coded to use high scores as an indicator of the high utility value of math.

Previous studies provide evidence for psychometric properties of TIMSS scale for value for math. For instance, Zhu and Leung (2011) investigated TIMSS 2003 scale with students from five East Asian and five western counties. The 5-item scale had good internal consistency (Cronbach's alpha = .76). All these five items were measured in TIMSS 2015 study.

Using TIMSS 2007 data of the students in the US, Chen (2011) reported high internal consistency (Cronbach's alpha = .725) of the 4-item scale of value for math. All these four items are part of TIMSS 2015 study.

Liou (2011) used TIMSS 2007 4-item scale for value for math as part of their investigation with students in the U.S., Australia, Czech Republic, Chinese Taipei, Tunisia, Saudi Arabia, and Singapore. The scale had high internal consistency (Cronbach's alpha = .74). Item-total correlation of the items is in the range of .52 to .61 and their factor loading is in the range of .72 to .80. All these four items are used in TIMSS 2015 study.

**Self-concept.**

The present study used self-concept, which is individuals' perception of themselves in a domain (Shavelson, Hubner & Stanton, 1976). EVT uses self-concept as a predictor of achievement motivation and achievement behavior. Eccles and Wigfield defined it as the cognitive evaluation of the ability to work on a task or in a domain (Eccles, 1983). Agreeing with Eccles and Wigfield on the definition of the construct, Marsh (1986) proposed the prediction of self-concept through the internal reference of

achievement in another domain and external reference of peer achievement in the I/E Model. The present study measured self-concept of math and used science achievement as the internal reference and average school achievement in math as the external reference of math self-concept (Figure 3).

TIMSS 2015 included a 9-item Likert-Type scale to measure students' confidence in math (Table 1). Conceptually, these items are consistent with self-concept construct in EVT and I/E Model. For instance, items "I usually do well in math" and "I learn things quickly in math" measure student's self-evaluation to work on math. For this reason, the present study used these nine items to operationally define middle school students' self-concept for math. Four items on TIMSS scale were negatively worded including "Math is not my strength" and "Math is more difficult for me than for many of my classmates". All items on the scale were responded in the range from 1 (*agree a lot*) to 4 (*disagree a lot*). Except for the four negatively worded items, the items on the scale were reverse coded to use high scores as an indicator of high self-concept for math.

Prior research offers evidence of the psychometric properties associated with TIMSS scale for student confidence in math. For instance, Elkof (2007) reported good internal consistency (Cronbach's alpha = .82) of the 5-item scale used in TIMSS 2003 with students from Sweden. The factor loading of items on the scale were in the range of .627 to .85 while their loading on another factor were between .014 and .207, thus the scale had good convergent validity. Four of these items are included in TIMSS 2015, which did not include the item: "When I do not understand a new math topic immediately, I know I will never understand".

Liu and Meng (2010) investigated TIMSS 2003 scale for students' confidence with students from Japan, Taiwan, Hong-Kong, and the US. Principal component analysis (PCA) informed loading of six items on the scale (Cronbach's alpha = .74 to .84). Five of these items are used in TIMSS 2015 study.

Choi, Choi, and McAnninch (2012) explored TIMSS 2007 scale for students' confidence in math with data of students from eleven top-performing countries. They reported good internal consistency of the scale (Cronbach's alpha = .78 to .86). Three of the four items on the scale are used in TIMSS 2015 study, which did not include the item: "I am not good at math".

**Achievement test.**

TIMSS aims to report curriculum coverage and assessment trends by capturing student achievement across countries. For this reason, in each test cycle, TIMSS produces about 200 items to test students of one grade in one domain. The 200 items for math in grade eight cover content areas of number, algebra, geometry, and data and chance. To facilitate student's attempt on the achievement test, TIMSS provides a 45-minutes long test booklet to each student. This test booklet comprises a portion of the pool of 200 items. Consequently, each student's score is representative of his or her response to a sample of items. This partial scoring makes it difficult to report comparable student achievement (Elkof, 2011) while TIMSS reporting is mainly normative in nature (i.e., Mullis, Martin, Foy, & Arora, 2012; Martin, Mullis, Foy, & Hooper, 2016). To reach to comparable student scores, TIMSS estimates five plausible values for the achievement of each student through item-response theory. These plausible values represent students' achievement if they had responded to all the items (Foy & LaRoche, 2016). These

plausible values are reported on a scale with a mean of 500, and a standard deviation of 100. MPlus program of data analysis combines results from separate analyses using each of the five plausible values.

## Data Analysis

In the present study, I used One-Way ANOVA and Structural Equation Modelling (*SEM, hereafter*) method to test the effectiveness of the theoretical framework for explaining math achievement gap between middle school students in the US and those in East Asia. For *SEM*, I used MPlus software (Muthen & Muthen, 1998-2015) to run the analysis.

### Descriptive statistics.

*SEM* runs with certain assumptions about the data, which require checking before testing the model (Hoyle & Isherwood, 2013). These assumptions include normality of data, sample size, missing data, and reliability of observed variables (Ainur, Sayang, Jannoo, & Yap, 2017; McDonald & Ho, 2002).

*SEM* requirement of the normal distribution of data is tested by measuring skewness and kurtoses (Garrido, Abad, & Ponsoda, 2016). Skewness shows the location of the mode of the data in relation to its mean. Kurtosis informs about the degree of peakedness in the shape of the distribution (Hinkle, Weirsma, & Jurs, 2003). Skewness greater than 3.0 and kurtosis greater than 10 indicates a violation of normality of data distribution (Ainur, Sayang, Jannoo, & Yap, 2017). I used this threshold to determine normality of each scale in the model. I tested the normality of scales for the overall data and for each of the six countries in the model.

*SEM* is a large-sample technique (Taasoobshirazi & Wang, 2016). The minimum requirement of a number of cases for each parameter (relationships prescribed in the model) is 20 (Kline, 2011). In the present study, the size of the sample from each country was more than 4000, making a total of 36,257. Thus, this criterion is satisfied.

For *SEM*, missing cases of less than 5% of a large sample are acceptable (McDonald & Ho, 2002) as this much missing information is not expected to influence the results. I used the missing data test in SPSS to identify the percentage of cases, which are missing. This test also informs the presence of any pattern in the missing data. I ran the test for each item in the model, and with data from each country separately.

### Structural equation modeling.

Following the general practice of *SEM* (Ainur, Sayang, Annoo, & Yap, 2017), the analysis in the present study comprised measurement and structural models. Testing of measurement model informs about the relatedness of the observed variables with the latent factors, while testing of structural model tells about the relatedness among the latent factors and about the predictive power of the model.

#### *Measurement model.*

Before testing the theoretical model, I tested the representation of latent factors by the observed indicators, comprising TIMSS scales and achievement scores, through measurement modeling. I ran this part of the analysis in two steps. First, I tested measurement model for the overall sample to know if the overall data fit the model. Second, I employed multigroup analysis, comparing the East Asian countries to the US.

Goodness-of-fit measures indicate how the covariance matrix implied in the researcher's model and the sample covariance matrix match (McDonalds & Ho, 2002). The present study used chi-square test, standardized root-mean-square SRMR), root-mean-square error of approximation (RMSEA), comparative fit indices (CFI), and Tucker-Lewis Index (TLI) as the goodness-of-fit indices for both measurement and structural equation models. The criteria to assess the model fit are SRMR (good fit: $\leq$.08; acceptable fit: $\leq$.1), RMSEA (good fit: $\leq$.05; acceptable fit: $\leq$.07), CFI (good fit: $\geq$.95; accepted fit: $\geq$ .90), and TLI (good fit: $\geq$.95; accepted fit: $\geq$.90) (Berndt & Williams, 2013; Garrido, Abad, & Ponsoda, 2016; Hu & Bentler, 1999; McDonald & Ho, 2002).

***Structural model.***

In the present study, I employed structural modeling to test the theoretical model. I first tested the model for its fit to the overall data. After getting acceptable fit indices, I ran the model for the students in the US and those in each of the countries in East Asia. The relationship among factors in these models informed how achievement motivation works in these countries with student achievement. Thus, the analysis results provided a cultural explanation of the math achievement gap between the students in the US and those in high achievement countries in East Asia. The same fit measures and criteria previously mentioned are used to assess model fit.

# Chapter Four: Results

## Missing Data Analysis

The starting sample for the present study comprised 36,257 grade eight students in Chinese Taipei (Taiwan), Hong Kong, Japan, Korea, Singapore, and the United States. However, the analysis required exclusion of 142 participants who had not responded to any of the 27 items on the three scales for self-concept, intrinsic value, and utility value. As the deleted cases did not exceed 1% in any of the six countries in the sample (Table 2) these cases, with all missing data, are not systemic by country.

Table 2. *Cases with Missing Data on All Items Across the Six Countries*

| Country | Case | Deleted | % deleted |
|---|---|---|---|
| Chinese Taipei | 5711 | 5 | 0.1 |
| Hong Kong | 4155 | 10 | 0.2 |
| Japan | 4745 | 5 | 0.1 |
| Korea | 5309 | 1 | 0.0 |
| Singapore | 6116 | 19 | 0.3 |
| United States | 10221 | 102 | 1.0 |
| Total | 36257 | 142 | 0.4 |

With the remaining 36115 cases in the sample, I did the Little Test for Missing Completely at Random (MCAR) in SPSS. The MCAR test was significant (Chi-Square = 11658.252, *df* = 8203, Sig. = .000). The significant p-value indicated that missingness is not random and it does matter for the analysis. For data with 5% or more cases with missing values, it is recommended to handle the missing values with procedures such as

multiple imputation. For a large sample with 5% or fewer cases with missing values, procedures such as list-wise or pair-wise deletion are recommended (Garson, 2016). The data for the present study had 5.5% cases with missing values on one or more items. Given the proximity to limit, the decision was made to delete cases list-wise in order to conduct the ANOVA comparisons for the average scale scores. Within *SEM,* full information maximum likelihood was used to address missing data instead of multiple imputation.

**Descriptive Statistics**

In the present study, I used TIMSS 2015 scales to measure self-concept, intrinsic value, and utility value. Each of the three scales was comprised of nine items. Grade Eight students from the six countries in the sample responded to each of these items on a scale of 1 to 4. Scale scores were summed, so the range of responses on each of the scales was from nine to 36. Table 3 includes all descriptive statistics for each of the three scales.

On the scale for self-concept, the country mean of students was in the range of 20.56 to 24.63. The US had the highest mean. Chinese Taipei and the US exhibit the largest variability. Cronbach's Alpha varied in the range of .91 to .93, with highest internal consistency in the data from Chinese Taipei (Table 3).

On the scale for intrinsic value, the country mean of students was in the range of 21.30 to 25.34 (Table 3). Singapore had the highest mean. The US had the highest variability. Cronbach's Alpha was .94 in each country, except for .95 in Chinese Taipei (Table 3).

On the scale for utility value, the country mean of students was in the range of 23.66 to 29.46. The US had the highest mean and Hong Kong the highest variability.

Cronbach's Alpha varied in the range of .86 to .91, with highest internal consistency in the data from Singapore (Table 3). It is important to note that the Cronbach's Alpha was above the cut score of .7 (Cho & Kim, 2015; Cortina, 1993) for each of the scales in all the countries, therefore the data offers internal consistency.

Table 3. *Descriptive Statistics of the Three Scales Related to Math Beliefs*

| Scale | Country | Mean | *SD* | Cronbach's Alpha | Skewness | Kurtosis |
|---|---|---|---|---|---|---|
| Self-Concept | Chinese Taipei | 21.02 | 7.049 | 0.93 | 0.3 | -0.7 |
| | Hong Kong | 22.03 | 6.625 | 0.91 | 0 | -0.5 |
| | Japan | 20.56 | 6.041 | 0.9 | 0.2 | -0.4 |
| | Korea | 22 | 5.799 | 0.91 | 0.2 | -0.2 |
| | Singapore | 23.07 | 6.705 | 0.91 | -0.1 | -0.7 |
| | US | 24.63 | 6.956 | 0.9 | -0.2 | -0.8 |
| Intrinsic Value | Chinese Taipei | 21.77 | 7.131 | 0.95 | 0.12 | -0.69 |
| | Hong Kong | 22.85 | 7.405 | 0.94 | -0.1 | -0.78 |
| | Japan | 21.52 | 6.634 | 0.94 | 0.18 | -0.5 |
| | Korea | 21.3 | 6.597 | 0.94 | 0.13 | -0.41 |
| | Singapore | 25.34 | 7.161 | 0.94 | -0.35 | -0.67 |
| | US | 22.89 | 7.923 | 0.94 | -0.07 | -1 |

Table 3 (continued)

| Scale | Country | Mean | *SD* | Cronbach's Alpha | Skewness | Kurtosis |
|---|---|---|---|---|---|---|
| Utility Value | Chinese Taipei | 23.66 | 6.007 | 0.9 | 0.25 | -0.09 |
| | Hong Kong | 25.4 | 6.123 | 0.91 | 0.38 | 0.02 |
| | Japan | 24.96 | 5.205 | 0.86 | 0.33 | 0.44 |
| | Korea | 25.33 | 5.309 | 0.88 | 0.39 | 0.59 |
| | Singapore | 28.85 | 4.803 | 0.87 | 0.66 | 0.71 |
| | US | 29.46 | 5.5 | 0.89 | 1.05 | 1.04 |

Table 3 shows skewness and kurtosis statistics, which are used to evaluate normality. Particularly noticeable were the differences in the shape of the distributions for each of the countries. There was a "US versus others" pattern in kurtosis, which was platykurtic[7] in all the countries; however, it was the highest in the US. The higher value of kurtosis is indicative of flatter and wider normal distribution. The scale for self-concept had skewness in the range of 0.00 to 0.30 and kurtosis was in the range of 0.20 to 0.80. The scale for intrinsic value had skewness in the range of 0.07 to 0.35 and kurtosis was in the range of 0.5 to 1.00. The US had the highest value of kurtosis. While the scale for utility value had skewness in the range of 0.25 to 1.05 and kurtosis was in the range of 0.02 to 1.04. The data on the three scales in the six countries had skewness below 3.0 and kurtosis below 10, which are the thresholds for normality of data distribution (Ainur, Sayang, Jannoo, & Yap, 2017). Therefore, the data offered normality in its distribution.

[7] Less than 3, and indicative of normal distribution.

**One-Way ANOVA**

In the next stage, I used a One-Way Analysis of Variance (ANOVA) to compare the mean level of self-concept, intrinsic value, and utility value of students in the US with those in the top-performing countries in East Asia.

In the first step, I did an ANOVA test for the five East Asian Countries (Chinese Taipei, Hong Kong, Japan, Korea, and Singapore) to determine if these countries were homogenous.

The test for homogeneity of variance was significant for each of the three scale scores (Table 4). These results indicate that the assumptions underlying the application of ANOVA were not met. Therefore, I used the Welch's Robust Test of Equality of Means as an alternative to One-Way ANOVA test for each of the three scales.

Table 4. *Test of Homogeneity of Variance Among East Asian Countries*

| Construct | Levene Statistic | *df1* | *df2* | Sig. |
|---|---|---|---|---|
| Self-Concept | 89.956 | 4 | 25639 | .000 |
| Intrinsic Value | 38.862 | 4 | 25620 | .000 |
| Utility Value | 80.958 | 4 | 25752 | .000 |

The results of the Welch's test informed a significant main effect on each of the scale means. They indicated that student perceptions of self and motivation were not the same across the five East Asian countries. The Omega for the three perceptions indicated that approximately 2% to 10% of the variance was attributed to the difference among the countries (Table 5).

Table 5. *Welch's Test in East Asian Countries*

| Construct | *F* | *df1* | *df2* | Sig. | $\omega^2$ |
|---|---|---|---|---|---|
| Self-Concept | 123.057 | 4 | 12454.83 | .000 | 0.02 |
| Intrinsic Value | 320.654 | 4 | 12431.05 | .000 | 0.05 |
| Utility Value | 827.084 | 4 | 12364.41 | .000 | 0.10 |

To identify the difference in the mean scores of students from the five East Asian countries, I used post hoc comparisons using Games-Howell procedures. On the scale of self-concept, all East Asian countries were different from each other except Korea and Hong Kong. On the scale of intrinsic value, the mean score of students was different from each other except that of Japan, Chinese Taipei, and Korea. On the scale of utility value, the mean score of students was different from each other except Korea and Hong Kong. On the three scales, there were instances when the mean scores of Chinese Taipei, Hong Kong, Japan, and Korea were not significantly different from each other. However, the mean scores of students in Singapore did not overlap with any country (Table 6), also Singapore had the highest mean among East Asian countries on all three scales (Table 3). Taken together, the Welch's Test results within East Asia indicate that these countries did not form a homogeneous group. The next step was One-Way ANOVA test to compare the perceptions of students in the US with each of the five East Asian countries.

Table 6. *Games-Howell Post Hoc Test for East Asian Countries*

| Country (I) | Country (J) | Mean Difference (I-J) | | |
|---|---|---|---|---|
| | | Self-Concept | Intrinsic Value | Utility Value |
| Chinese Taipei | Hong Kong | -1.01* | -1.08* | -1.75* |
| | Japan | 0.46* | 0.25 | -1.29* |
| | Korea | -0.98* | 0.47* | -1.67* |
| | Singapore | -2.05* | -3.56* | -5.20* |
| Hong Kong | Chinese Taipei | 1.01* | 1.08* | 1.75* |
| | Japan | 1.47* | 1.32* | 0.45* |
| | Korea | 0.03 | 1.54* | 0.08 |
| | Singapore | -1.05* | -2.48* | -3.45* |
| Japan | Chinese Taipei | -0.46* | -0.25 | 1.30* |
| | Hong Kong | -1.47* | -1.32* | -0.45* |
| | Korea | -1.44* | 0.22 | -0.37* |
| | Singapore | -2.51* | -3.81* | -3.90* |
| Korea | Chinese Taipei | 0.98* | -0.47* | 1.67* |
| | Hong Kong | -0.03 | -1.54* | -0.08 |
| | Japan | 1.44* | -0.22 | 0.37* |
| | Singapore | -1.07* | -4.03* | -3.53* |
| Singapore | Chinese Taipei | 2.05* | 3.56* | 5.20* |
| | Japan | 2.51* | 3.81* | 3.90* |
| | Korea | 1.07* | 4.03* | 3.53* |

Note. * = The mean difference is significant at the 0.01 level.

The test for homogeneity of variance across the six countries was significant (Table 7). These results indicate that the assumptions underlying the application of

ANOVA were not met. Thus, Welch's Robust Test of Equality of Means was conducted instead of One-Way ANOVA.

Table 7. *Test of Homogeneity of Variance in Six Countries*

| Construct | Levene Statistic | *df1* | *df2* | Sig. |
|---|---|---|---|---|
| Self-Concept | 104.091 | 5 | 35364 | .000 |
| Intrinsic Value | 106.343 | 5 | 35128 | .000 |
| Utility Value | 69.934 | 5 | 35574 | .000 |

Results from the Welch's test inform a significant main effect. These results indicate that students' perceptions of self and motivation were not the same across the six countries (Table 8) as the mean of the six countries were significantly different from each other on the three scales.

Table 8. *Welch's Test for Six Countries*

| Construct | *F* | *df1* | *df2* | Sig. |
|---|---|---|---|---|
| Self-Concept | 349.508 | 5 | 14966.21 | .000 |
| Intrinsic Value | 259.101 | 5 | 14988.21 | .000 |
| Utility Value | 1224.837 | 5 | 14852.25 | .000 |

In the next step, I used post hoc comparisons using Games-Howell procedures to compare mean scores of students in the US with those in the five East Asian countries. The Games-Howell Post Hoc test informed that on the scale of self-concept, the mean score of students in the US was significantly different from all other countries. On the scale of intrinsic value, the mean score of students in the US was different from the East Asian countries except for Hong Kong. While on the scale of utility value, the mean

score of students in the US was significantly different from all East Asian countries (Table 9).

Table 9. *Games-Howell Post Hoc Test Comparing the US to Each East Asian Country*

| Country (I) | Country (J) | Mean Difference (I-J) | | |
|---|---|---|---|---|
| | | Self-Concept | Intrinsic | Utility |
| United States | Chinese Taipei | 3.61* | 1.12* | 5.80* |
| | Hong Kong | 2.61* | 0.04 | 4.05* |
| | Japan | 4.07* | 1.36* | 4.50* |
| | Korea | 2.64* | 1.58* | 4.13* |
| | Singapore | 1.56* | -2.45* | 0.60* |

Note. * = The mean difference is significant at the 0.01 level.

To conclude, the middle school students in the US had the highest and significantly different mean score for self-concept and utility value (Table 3, Table 9). Thus, the results provide supporting evidence to the research hypothesis that students in the US have a significantly higher level of self-concept and utility value. However, their mean score on the scale for intrinsic value was not the highest (Table 3) and was not significantly different from all the East Asian countries (Table 9) thus the same claim cannot be made for this construct.

**Structural Equation Model**

In the next step, I ran the structural equation model (*SEM*, *hereafter*) (Figure 3) to further compare self-concept and motivation between the middle school students in the US and those in the top-performing countries in East Asia as an explanation of the math achievement gap between these two populations. I used *SEM* to test the relationship of

motivation and self-concept with students' math achievement, and the relationship of science achievement, the internal factor, and peer math achievement, the external factor, with self-concept and motivation. The construct of *self-concept of math, the perception of ability in math*, represented self-concept, while *intrinsic value* and *utility value* represented motivation. The average math achievement in the school represented peer achievement. Five plausible values of student scores on math and science tests represented students' math and science achievement. I ran *SEM* with full information maximum likelihood on MPlus software to investigate the relationship among these factors.

*SEM* requires certain conditions to be fulfilled by the data for accurate results. These conditions include independent observations, missing value $\leq$ 5%, and multivariate normality in endogenous variables (Kline, 2011). As described in chapter three, TIMSS utilizes a two-stage random sample design in each country, with a sample of schools in the country drawn in the first stage, and one or more classes drawn in each of the sampled schools in the second stage. Therefore, the data fulfilled the independent observation condition. The percentage of missing value was 5.5 thus, was on the borderline. Multivariate normality was reported through the investigation of univariate distributions. Both skewness and kurtosis were below two (Table 3) thus were below the threshold of three for skewness and 10 for kurtosis (Ainur, Sayang, Jannoo, & Yap, 2017). Further, bivariate correlations (Table 13) were in the range of .012 to .710, thus show linearity. The correlation between math and science achievement was .845. This high correlation is in line with Marsh's (1986) internal/external frame of reference model, which presents

the significant positive correlation between achievement in two domains i.e., math and verbal.

As mentioned in chapter three, chi-square test, standardized root-mean-square (SRMR, *hereafter*), root-mean-square error of approximation (RMSEA, *hereafter*), comparative fit indices (CFI, *hereafter*), and Tucker-Lewis Index (TLI, *hereafter*) were used as the goodness-of-fit measures for both measurement and structural models and will be referred to while reporting the results. The criteria to assess the model fit were SRMR (good fit: $\leq$.08; acceptable fit: $\leq$.1), RMSEA (good fit: $\leq$.05; acceptable fit: $\leq$ .07), CFI (good fit: $\geq$.95; acceptable fit: $\geq$ .90), and TLI (good fit: $\geq$.95; acceptable fit: $\geq$ .90) (Berndt & Williams, 2013; Garrido, Abad, & Ponsoda, 2016; Hu & Bentler, 1999; McDonald & Ho, 2002;).

**The measurement model.**

The measurement model comprised three latent factors: self-concept, intrinsic value, and utility value. In the present study, I used TIMSS 2015 scales to measure these constructs. Each of the three TIMSS scales comprised nine items. The measurement model had good SRMR and acceptable RMSEA results (Table 11) but the results were below the threshold values for good fit for CFI and TLI. The model met two of the four criteria for model fit, thus it was an acceptable model (Hu & Bentler, 1999). The item-to-factor loadings for self-concept were in the range of .528 to .808. The item-to-factor loadings for intrinsic value were in the range of .617 to .878. The item-to-factor loadings for utility value were in the range of .582 to .820. All the loadings were significant.

**The structural model.**

In the present study, I used a structural model comprising peer achievement, science achievement, self-concept, intrinsic value, and utility value to predict math achievement (Figure 3). The structural model for the overall data offered a good fit for SRMR and RMSEA (Table 10). All the paths in the model were significant. Self-concept (.15) and intrinsic value (.07) had positive, while utility (-.06) had a negative relationship with math achievement. Science achievement had a positive correlation (.37) with self-concept and negative correlation (-.12) with intrinsic value. Peer achievement had a negative correlation (-.22) with self-concept while positive correlation (.13) with intrinsic value.

Table 10. *Measurement and Structural Model Results for Overall Data*

| Model | *SRMR* | *RMSEA* | *RMSEA* [90% CI] | *CFI* | *TLI* | $X^2$ | *DF* | $X^2/DF$ |
|---|---|---|---|---|---|---|---|---|
| Measurement | 0.077 | 0.052 | 0.052 - 0.053 | 0.867 | 0.854 | 239821.14* | 351 | 683.251 |
| Structural | 0.074 | 0.05 | 0.050 -0.051 | 0.870 | 0.857 | 37619.926* | 396 | 95.000 |

Note. * = significant at .01 Level

**Multigroup analysis.**

After identifying acceptable model fit for the measurement and structural models of the overall data, the next step was multigroup analysis to investigate the differences in self-concept and motivation between the students in the US and those in the top-performing countries in East Asia. Earlier, the Homogeneity of Variance test results revealed differences in math self-concept and motivation within East Asia (Table 4), thus

each of the five East Asian countries was entered in the *SEM* model separately. The unconstrained measurement model, with all the six countries nested under the overall model, had *RMSEA* increase of .03 and *CFI* decrease of .05 from the structural model. Chen (2007)'s cut-off points for the rejection of measurement invariance are an increase of .015 or greater for the *RMSEA* and a decrease of .010 or greater for *CFI*. The unconstrained structural model improved the fit stats however *RMSEA* was .02 greater than the structural model (Table 11).

Table 11. *Nested Measurement and Structural Model Results*

| Model | *SRMR* | *RMSEA* | *RMSEA* [90% CI] | *CFI* | *TLI* | $X^2$ | *DF* | $X^2$ /*DF* |
|---|---|---|---|---|---|---|---|---|
| Measurement Unconstrained | 0.112 | 0.083 | 0.083 - 0.084 | 0.817 | 0.813 | 88064.863* | 2061 | 42.729 |
| Measurement Equal Loading | 0.118 | .076 | 0.076 - 0.077 | 0.828 | 0.830 | 95522.645 | 1459 | 65.47 |
| Structural Unconstrained | 0.122 | 0.071 | 0.071 - 0.072 | 0.858 | 0.853 | 78826.026* | 2505 | 31.467 |

Note. * = significant at .01 Level

The measurement invariance was investigated by looking into item-to-factor loading across countries. Factor loadings revealed variations across countries. For instance, the item "Math makes me nervous" loaded on self-concept factor in the range of .36 to .58 (Figure 4), the item "I enjoy learning math" loaded on intrinsic value in the range of .71 to .91(Figure 5), and the item "I need to do well in math to get into the university of my choice" loaded on utility value in the range of .67 to .84 (Figure 6). Identifying measurement variance across countries, the decision was taken to run the model separately for each of the six countries.

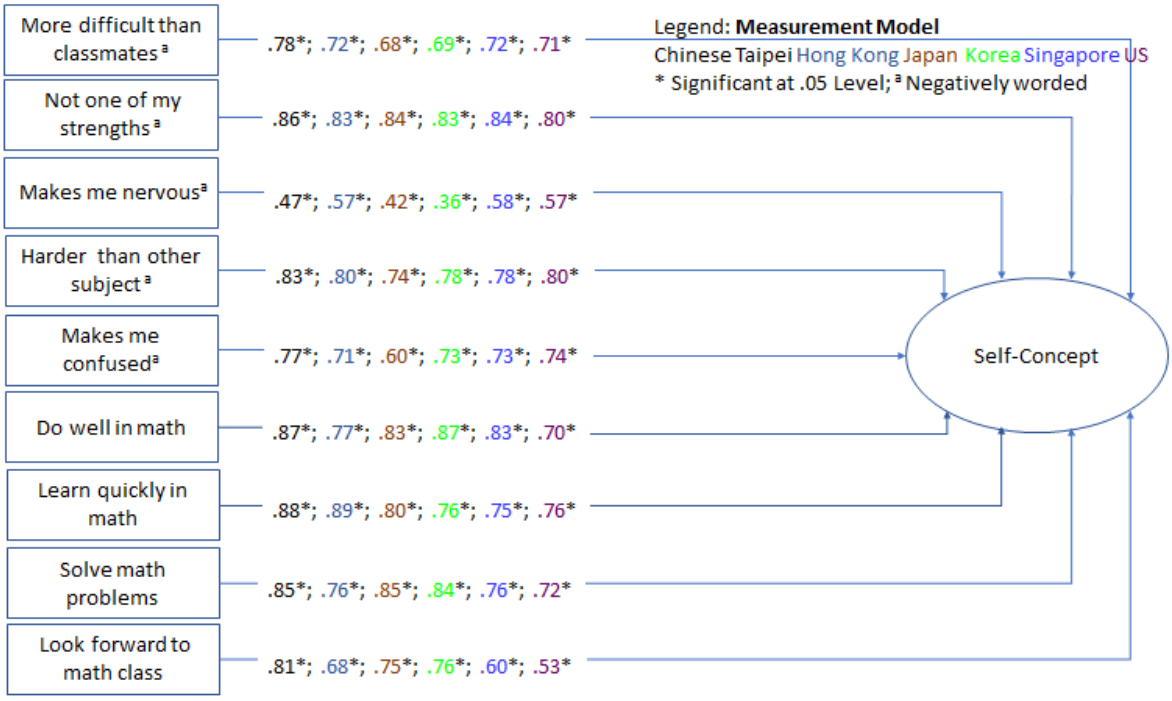


Figure 4. *Item Loading to Self-Concept Factor in the Six Countries*

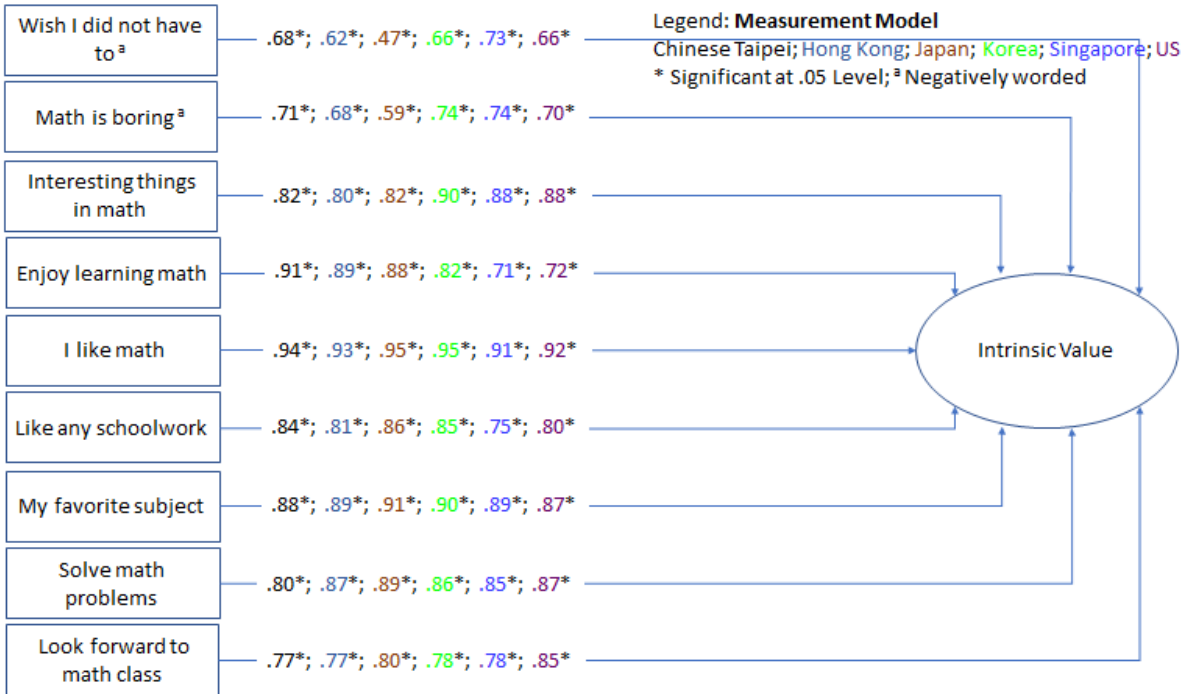


Figure 5. *Item Loading to Intrinsic Value Factor in the Six Countries*

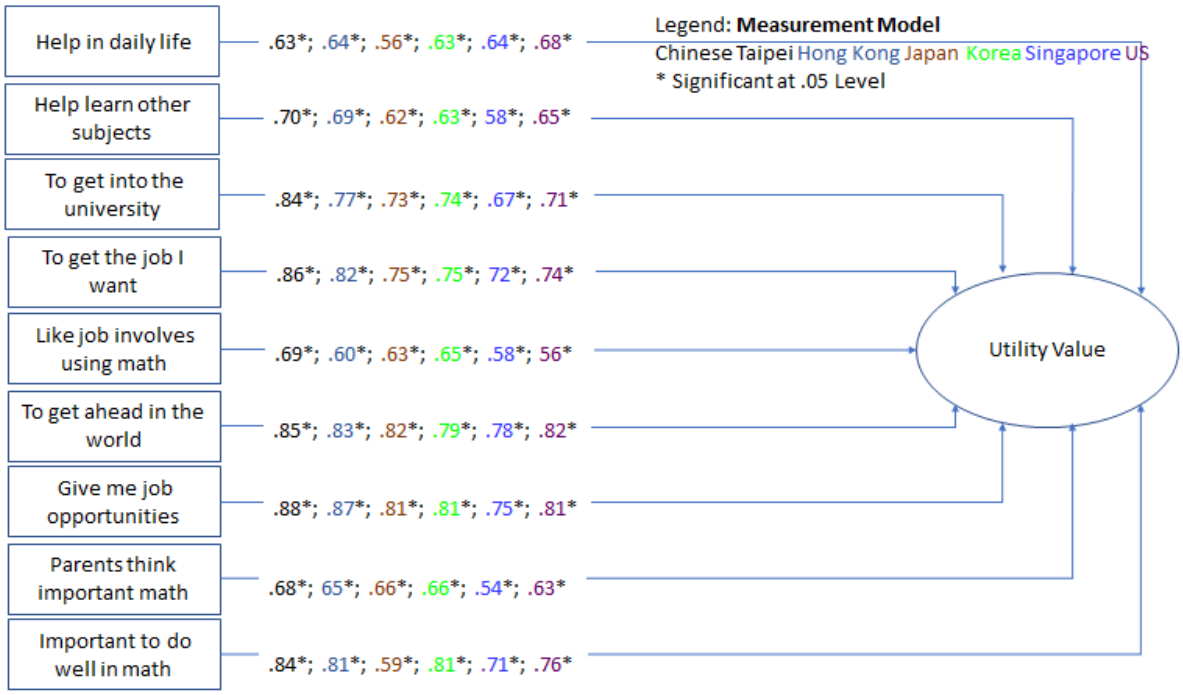


Figure 6. *Item Loading to Utility Value Factor in the Six Countries*

***Error covariance.***

The measurement model without any modification had *RMSEA* above .07 in all five East Asian countries. Error covariance between the item "I need to do well in math to get into the university of my choice" and "I need to do well in math to get the job I want" was added to improve the models for these countries. Both the items load on utility value factor. They measure students' perceptions about the use of the domain in their future life. This covariance has been used by Chen (2011). The error covariances added to the structural model were between math and science achievement, peer and science achievement, and intrinsic and utility value. These error covariances were part of the structural model for overall data, structural unconstrained model, and the structural models for all six countries.

***Model fit across six countries.***

The model fit measures for measurement and structural models for the six countries had *SRMR* .08 or below while *RMSEA* was on the borderline. However, the structural model for Hong Kong had *RMSEA* above the threshold (Table 12).

Table 12. *Measurement and Structural Models for Six Countries*

| Country | *SRMR* | *RMSEA* | *RMSEA* [90% *CI*] | *CFI* | *TLI* | $X^2$ | *DF* | $X^2/DF$ |
|---|---|---|---|---|---|---|---|---|
| Measurement Model | | | | | | | | |
| Chinese Taipei | 0.066 | 0.072 | 0.070 - 0.073 | 0.885 | 0.874 | 9711.12* | 320 | 30.347 |
| Hong Kong | 0.078 | 0.069 | 0.068 - 0.070 | 0.874 | 0.861 | 8410.34* | 320 | 26.282 |
| Japan | 0.075 | 0.071 | 0.070 - 0.073 | 0.874 | 0.862 | 8031.99* | 320 | 25.100 |
| Singapore | 0.08 | 0.071 | 0.070 - 0.072 | 0.883 | 0.071 | 10235.1* | 320 | 31.985 |
| Korea | 0.078 | 0.069 | 0.068 - 0.071 | 0.874 | 0.861 | 8410.3* | 320 | 26.282 |
| The US | 0.079 | 0.069 | 0.068 - 0.070 | 0.874 | 0.862 | 15643.4* | 321 | 48.733 |
| Structural Model | | | | | | | | |
| Chinese Taipei | 0.064 | 0.069 | 0.068 - 0.070 | 0.886 | 0.875 | 11125.4* | 394 | 28.237 |
| Hong Kong | 0.088 | 0.075 | 0.074 0.077 | 0.85 | 0.841 | 9701.6* | 394 | 24.623 |
| Japan | 0.073 | 0.068 | 0.067 - 0.071 | 0.876 | 0.863 | 9148.2* | 394 | 23.219 |

Table 12 (continued)

| Country | *SRMR* | *RMSEA* | *RMSEA* [90% *CI*] | *CFI* | *TLI* | $X^2$ | *DF* | $X^2$ /*DF* |
|---|---|---|---|---|---|---|---|---|
| Singapore | 0.075 | 0.068 | 0.067 - 0.069 | 0.887 | 0.875 | 11429.03 * | 394 | 29.008 |
| Korea | 0.076 | 0.065 | 0.064 - 0.067 | 0.876 | 0.864 | 9341.24* | 394 | 23.709 |
| The US | 0.073 | 0.065 | 0.064 - 0.066 | 0.88 | 0.868 | 17112* | 395 | 43.322 |

Note. * = significant at .05 level

***Path coefficients across countries.***

The purpose of structural equation analysis was to identify the association of self-concept and motivation with achievement in the US and in the top-performing counties in East Asia. Standardized path coefficients were used to report that investigation (Figure 7). Self-concept positively related to math achievement in the US, as well as in all East Asian countries. However, the contribution was observably low in the US and Singapore. Intrinsic value positively associated with math achievement in the US, Singapore, and Hong Kong. It negatively related in Japan and Korea, and non-significantly related in Chinese Taipei. Utility value negatively linked to math achievement in the US, Korea, and Singapore and non-significantly linked in Chinese Taipei, Hong Kong, and Japan.

Science achievement, the internal factor, linked negatively to self-concept in the US and in all East Asian countries. Peer achievement in math, the external factor, linked to self-concept positively in the US. It related negatively in Chinese Taipei, Hong Kong, and Japan, while non-significantly in Korea and Singapore. Thus, there was a "US versus others" trend in the use of external references for self-concept.

Science achievement linked to intrinsic value negatively in the US, as well as in all East Asian countries. Peer achievement in math linked to intrinsic value non-significantly in the US, Chinese Taipei, and Korea. It linked significantly in Hong Kong, Japan, and Singapore. Thus, a "US versus others" trend was not seen in the use of internal and external reference for intrinsic value (Figure 7).

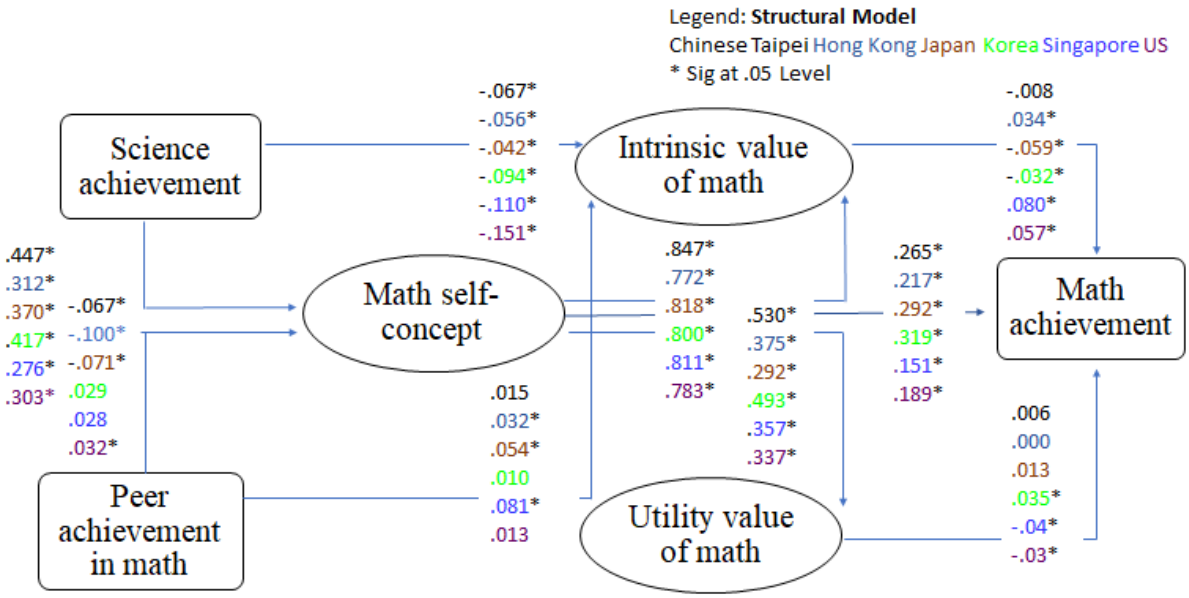


Figure 7. *Path Coefficients Across the Six Countries*

**Conclusion**

The analysis of TIMSS data from the US and from the five top-performing countries in East Asia was intended to identify differences in motivation and self-concept between the students from two different cultures. The results informed differences in the mean of self-concept and motivation (Table 9In the next step, I used post hoc comparisons using Games-Howell procedures to compare mean scores of students in the US with those in the five East Asian countries. The Games-Howell Post Hoc test informed that on the scale of self-concept, the mean score of students in the US was

significantly different from all other countries. On the scale of intrinsic value, the mean score of students in the US was different from the East Asian countries except for Hong Kong. While on the scale of utility value, the mean score of students in the US was significantly different from all East Asian countries (Table 9).

Table 9 There were a couple of differences between the US and the East Asian countries in the association of student achievement with self-concept and motivation and in the use of internal and external references in self-concept (Figure 7). These results are discussed in relation to the theoretical framework and prior research in the next chapter.

## Chapter Five: Discussion, Conclusions, and Recommendations

Chapter five presents an extensive discussion based on the results and is divided into four sections. The first section provides a summary of the study. Secondly, the results are described in relation to the research questions, to the theories of culture, motivation, and self-concept, which are used in the theoretical framework, and to the cultural, social, and educational systems in the six countries in the sample. Thirdly, the limitations of the present study are listed. Lastly, suggestions for future research are presented.

### Summary

The present study was conducted to understand the achievement of middle school students in the US who are ranked in the middle of the countries in international tests of achievement thus their achievement is moderate. For this purpose, I investigated the math achievement gap between the middle school students in the US and those in the top-performing countries in East Asia by looking into the differences in the influence of intrapersonal, interpersonal, and contextual factors on achievement. I used a theoretical framework comprising components of motivation and self-concept as intrapersonal, peer achievement as interpersonal, and culture as the contextual influence for the investigation (Figure 3) as motivation and self-concept are among the most significant intrapersonal influences on student achievement (Hattie, 2009) while culture shapes how a person thinks and behaves (Triandis, 2015). In particular, I used Eccles and Wigfield's model of expectancy-value theory (Eccles, 1983, Eccles & Wigfield, 2002) (EVT, *hereafter*), Marsh' internal/external frame of reference for self-concept (1986) (I/E model,

*hereafter)*, and Triandis' (1995) individualism/collectivism conception of culture (individualism/ collectivism, *hereafter*) as the main theories for analysis.

The study was made using a subset of data from Trends in International Mathematics and Science Study (TIMSS) 2015, with a sample comprising of 36,115 middle school students in Chinese Taipei (Taiwan), Hong Kong, Japan, Korea, Singapore, and the US. I specifically focussed on their responses on scales of confidence in math, likening for math, and value of math, and their scores on math and science achievement tests. It must be noted that these TIMSS scales have been used for representing self-concept, intrinsic value, and utility value (i.e., Marsh et al., 2014; Liou, 2017), which as described earlier, are the constructs that the present study used. The investigation was aimed to respond to the research question:

Does the proposed framework with motivation, self-concept, and culture explain moderate math achievement of middle school students in the US in comparison to those in the East Asian countries?

This question is answered while summarizing the responses to the three sub-questions as below.

Do achievement motivation and self–concept vary for students in the US from the students in East Asia?

In the study, I responded to the question by looking into the difference in the group mean of countries on self-concept and motivation constructs and in the strength of the relationship of these constructs with math achievement. I made the first investigation through Analysis of Variance (one-way ANOVA, *hereafter*) and the second investigation through multigroup structural equation modeling (*SEM*, *hereafter*) methods.

Do students in the US focus on internal reference while those in East Asia on external reference for self-concept and intrinsic value?

I answered this question by looking into the strength of the relationship of internal (science achievement) and external references (peer achievement) of self-concept and intrinsic value. I made this investigation using multigroup *SEM*.

Does individualism/collectivism serve as an explanation for the identified trends in motivation and self-concept?

I will make the response to the third question by synthesizing the findings made in the responses to question one and two.

## Detailed Discussion of Research Questions and Results

### Do achievement motivation and self-concept vary for students in the US from the students in East Asia? - The difference in the mean.

The first set of investigations was about the difference in the perceptions of the students about self-concept and motivation. The students in the US were hypothesized to have higher mean on the scales of self-concept, intrinsic value, and utility value. Results of Welch's Robust Test of Equality of Means and Games-Howell procedures on TIMSS 2015 data informed that the mean scores of students in the US were high and significantly different from the scores of the students in East Asia on the scales of self-concept and utility value of math. On the scale of intrinsic value, the mean score of students in the US was not the highest and was similar to the scores of students from Hong Kong (Table 8). Thus, the hypothesis about mean difference was partially true.

The finding of high self-concept of students in the US from those in East Asia is agreed by other researchers. For instance, Liu and Meng (2010) found high self-concept for math of low-performing middle school students in the US in comparison to the high performing students in Japan. Liou (2011) compared the level of self-concept of students from all 49 participating countries in TIMSS 2003. The results informed that Taiwan, Korea, Hong Kong, Japan, and Singapore form a cluster with the lowest self-concept among the countries while the US was clustered among countries with high self-concept. Yoshino (2012) compared self-concept in Japan and the US and reported low self-concept of students in Japan.

For utility, Liou (2017) reported the U.S. students with utility value high than Chinese Taipei, Japan, and Hong Kong but lower than those in Singapore. Mohammadpour (2012) found grade eight students in Singapore with low utility value in the hierarchical level analysis of TIMSS 2007 data from the country.

For intrinsic value, the invariance between students in the US and those in East Asia is agreed by Haichun, Haiyong, and Ang (2013) in their investigation with grade eight students from the US and China. Zhu and Leung (2011) also agreed on this invariance in their analysis of TIMSS 2003 likening for math scale for comparison of the East with the West using data from Hong Kong, Japan, Republic of Korea, Singapore, Chinese Taipei, Australia, England, the Netherlands, and the US.

**Do achievement motivation and self-concept vary for students in the US from the students in East Asia? – The difference in the relationship.**

The second set of investigations was about the difference between the students in the US and those in East Asia in the relationship of math achievement with self-concept,

intrinsic value, and utility value. The study hypothesized that students in the US have a comparatively weak relationship. This hypothesis was partially supported by the *SEM* findings, which provided instances of differences between the US and the counties in East Asia in the association of these three constructs with achievement. The relationship of self-concept with math achievement was positive in all the countries but it was observably weak in the US and Singapore. The relationship of intrinsic value with achievement was positive in the US, Hong Kong, and Singapore, negative in Korea and Japan, and non-significant in Chinese Taipei. The relationship of utility value was negative in the US and Singapore, positive in Korea, and non-significant in Chinese Taipei, Hong Kong, and Japan (Figure 5). Thus, there are mixed findings about the difference between the US and the countries in East Asia in the connection of self-concept and motivation with math achievement.

Kaya (2009) had the same finding of the positive contribution of self-concept in science achievement in East Asia (Singapore, Japan) and West (the US, Australia, and Scotland). Kaya used TIMSS 2003 data for science to make the investigation. Yu (2012) reported mixed findings in the prediction of math achievement by self-concept in TIMSS 2003 data. In Yu, the variation within the East Asian group made it difficult to synthesize the differences between the US and in the East Asian countries. The present study faced the same issue.

**Do students in the US focus on internal reference while those in East Asia on external reference for self-concept and intrinsic value?**

The third set of investigation was about the difference in the relationship of self-concept and motivation with internal and external references. The present study assumed

the use of internal reference by the students in the US and the use of external reference by the students in East Asia for self-concept and intrinsic value. For self-concept, the *SEM* results show a positive association with science achievement, the internal reference, in both the US and East Asia. There was a positive association with peer achievement, the external reference, in the US, negative association in Chinese Taipei, Hong Kong, and Japan, and non-significant association in Korea and Singapore. Thus, there is "US versus others" trend in external referencing of self-concept.

For intrinsic value, the association with science achievement was negative in the US and in five East Asian countries. The association with peer achievement was non-significant in the US, Chinese Taipei, and Korea, and positive in Hong Kong, Japan, and Singapore. Thus, the "US versus others" trend does not exist in internal and external referencing of intrinsic value.

Marsh and Hue (2003) tested the external reference of peer achievement in 26 countries using Program of International Student Assessment (PISA) 2001 data. Korea and the US were included in the sample. In Korea, the relationship was non-significant and the lowest among the 26 countries. In the US, the relationship was negative. The results of the study match with the present study for Korea but not for the US.

Marsh et al. (2015) investigated the internal referencing in math and science in East Asia comprising Hong Kong, Japan, Singapore, and Chinese Taipei, the West including the US, and the Middle East. The results inform negative input from science achievement to math self-concept and math intrinsic value across countries. These findings are in agreement with the findings of the present study for intrinsic value but not for self-concept. It is to note that Marsh et al. did not use negatively-worded items in

TIMSS 2007 scales while the present study used all the items in TIMSS 2015 scales and handled the negatively-worded items separately from the positively-worded items while reverse coding student responses.

Salchegger (2015) investigated external referencing of peer achievement on math self-concept using PISA 2003 data in 41 countries including Hong Kong, Japan, Korea, and the US. The study reported negative input by the external reference in all the countries. In the present study, the input is non-significant in Korea and is positive in the US.

Wang (2015) investigated the external reference in 49 countries including Hong Kong, Japan, Korea, Chinese Taipei, and the US. The analysis of TIMSS 2007 data for math informed of the significant and negative relationship of peer achievement across all the countries. This does not match with the positive relationship found in the present study.

To summarize, the result of the present study on external referencing of self-concept in the US does not agree with other studies. However, it fits with the notion of assimilation process in internal and external comparisons in the I/E model. In these comparisons both contrast and assimilation processes take place. In external comparisons, when students consider themselves different from their peers, the contrast process dominates and leads to negative correlation in achievement and self-concept. When students take themselves similar to their peers, the assimilation process dominates and leads to a positive correlation between achievement and self-concept (Moller & Marsh, 2013). Greenfield (2017) advocates for the anticipation of such differences in findings, and suggests using them as a trigger for investigation of cultural and behavioral changes

across time. This different result of the present study is discussed in detail later in the chapter.

**Does individualism/collectivism serve as an explanation for the identified trends in motivation and self-concept?**

Self-concept operates differently in the West including the US, and in the East including Chinese Taipei (Taiwan), Hong Kong, Japan, Korea, and Singapore (Markus and Kityama, 1991). Traindis (1995) explained this difference by suggesting that in West, as individualist cultures, perceptions about self and motivation are developed while looking into self, and in the East, being collectivist cultures, perceptions about self and motivation are developed while looking at the group. Also, these perceptions are inflated in individualist cultures and are realistic in collectivist cultures (Triandis & Gelfand, 2012). Based on Triandis' cultural constructs, the present study hypothesized mean level of self-concept, intrinsic value, and utility value to be high in the US as compared to the East Asian countries in the sample. Secondly, it hypothesized weaker relationship of math achievement with self-concept, intrinsic value, and utility value in the US. Thirdly, it hypothesized more use of internal reference, operationalized by science achievement, and less use of external reference, operationalized by peer achievement, for self-concept and intrinsic value, in the US (Figure 3).

Firstly, the present study found significantly high mean value of self-concept and utility value in the US (Table 9). Thus, there is a difference in how students perceive themselves and the domain in the individualist culture of the US from those in the collectivist cultures in East Asia. Students in the US think highly of themselves and believe that math is important for their current and future goals. While students in East

Asia think modestly about themselves and take math comparatively less important for themselves. Secondly, the relationship of achievement with self-concept is observably weak in the US and Singapore. Thus, in the US, self-concept is comparatively less connected to students' actual ability. The self-concept of students in Chinese Taipei, Hong Kong, Korea, and Japan is closer to their ability. The finding of observably low connection of self-concept with math achievement, in combination with the finding of high and significantly different self-concept, gives the impression that students in the US have inflated self-concept.

In the present study, the influence of intrinsic value on achievement is positive in the US, Singapore, and Hong Kong, is non-significant in Chinese Taipei, and is negative in Korea and Japan. This mixed trend cannot be linked with Triandis' individualism/collectivism. The relationship of utility value with achievement is negative in the US and Singapore while positive or non-significant in the rest of the countries. This means that if the U.S. students give more importance to math, they tend to score low in math exams. The interaction in self-concept and utility value can inform if this valuation of math is linked to how the students think of themselves. It is possible that the students who overrate their ability in math and consider the domain not important have less stress about exams and end-up scoring high. This needs to be investigated further.

Thirdly, there is no variation across the six countries in the use of internal reference for self-concept and intrinsic value. While the use of external reference for self-concept is positive in the US, it is negative or non-significant in the other countries. Also, the use of external reference for intrinsic value is non-significant in the US, Korea, and Chinese Taipei, while positive in Hong Kong, Japan, and Singapore (Figure 5). To

synthesize, for both self-concept and intrinsic value, there is a cultural influence on external referencing. The students in the US take high ability peers in a good spirit unlike the students in East Asia. The company does matter to them but not in the competitive sense. Their enjoyment in math does not depend on the company; they are self-reliant for that. The present study hypothesized the students in the US to use more internal referencing and students in East Asia to use more external referencing. The results do not support this hypothesis. However, the study finds that external referencing is more sensitive to context. To understand the influence of context on the use of external referencing by the students in the US, I discuss different aspects of the context in details later.

Moving to the broader research question, the present study used a framework with motivation, self-concept, and culture to explain moderate math achievement of middle school students in the US in comparison to those in the East Asian countries. The results inform that external reference is linked differently to self-concept and motivation; self-concept and utility value have high mean values; and their association with achievement is different in the US as compared to the top-performing countries in East Asia. At the same time, there is a similarity between the US and the top-performing countries in internal referencing, mean value of intrinsic value, and in its association with achievement. Thus, aspects of self-concept and motivation, which are related to the context, work differently in the US. The present study used these aspects to understand the moderate achievement of middle school students in the US. They do not believe in competition with peers as the students in East Asia do. The U.S. students who value math more, score low in achievement exams. Thirdly, their perception of self is comparatively

linked weakly to their achievement. These student characteristics, besides other factors, are expected to contribute to the moderate achievement of students in the US.

### Results in relation to other theories in the framework.

#### *Results in relation to Marsh's internal/external frame of reference model.*

In the I/E model, Marsh explains the almost null relationship of verbal and math self-concept by the positive input from achievement while using external reference of peer achievement, and the negative input from achievement while using internal reference of achievement in another domain. This framework is extended to the relationship between math and science by proposing positive internal input from achievement to self-concept (Moller & Marsh, 2013). Linking this internal/external referencing to Triandis' I/C model, the present study hypothesized math self-concept's internal referencing to be higher in the US while external referencing to be higher in East Asia. Secondly, the present study extended the hypothesis for internal/external reference to intrinsic value. The results inform that internal reference influences self-concept positively in the US and in the East Asian countries. Thus, there is evidence for internal referencing from all six countries. External reference influences self-concept positively in the US, non-significantly in Korea and Singapore, and negatively in Chinese Taipei and Hong Kong. Thus, external referencing of self-concept varies across countries and is more context-specific.

Internal referencing of intrinsic value is negative across the six countries in the sample. External referencing is non-significant in the US, Korea, and Chinese Taipei and is positive in other three East Asian countries. Like internal referencing of self-concept, the study expected a positive relationship between science achievement and math

intrinsic value, but found it to be negative. Thus, the link from achievement to the perception of the domain is different from the link students form for developing their perception of self. Similar results across the countries show consistency in the link formation. Like the external referencing for self-concept, the external referencing for intrinsic value is more context specific.

***Results in relation to Eccles and Wigfield's model of expectancy-value theory.***

Eccles and Wigfield explained achievement behavior by the motivational constructs of subjective task values and expectancy of success in their model of expectancy-value theory. The present study investigated the influence of intrinsic value, utility value, and self-concept on math achievement. It hypothesized weaker relationship of achievement in the US, compared to those in the students in East Asia. The results informed that the relationship of intrinsic value is positive in the US, Singapore, and Hong Kong, is negative in Korea and Japan, and non-significant in Chinese Taipei. The relationship of utility value is negative in the US and Singapore, positive in Korea, and non-significant in Chinese Taipei, Japan, and Hong Kong. These negative relationships do not match the theoretical assumptions and are discussed later in detail in relation to culture, as well as, education, social, and political systems. The study found positive relationship of self-concept across the six countries but it is observably low in the US and Singapore (Figure 5).

To sum up, firstly, this study found mixed results about the relationship of self-concept and motivation on achievement among the five East Asian countries thus these constructs contribute to achievement differently within this cultural group. Secondly, a country or two came up with results similar to the US, but overall the contribution of

these three constructs in achievement is different in the US, as compared to the East Asian countries. Thirdly, the relationship of intrinsic value with achievement was found to be different from that of utility value across the countries in the sample. This finding provides an evidence that each subjective task value has a unique relationship with the achievement behavior. Eccles and Wigfield's model looks into the cumulative effect of the four subjective values and expectancy of success on achievement behavior. However, an investigation of the effect of each of them provides more insights on how motivation works differently in each culture.

### Results in relation to culture, history, and social and education systems.

#### *The US.*

The results that the students in the US have high and significantly different mean value of utility value (Table 9) indicate that these students value the domain and consider it as being important in their current and future goals. However, utility value negatively contributes to achievement in the US (Figure 5). Thus, the students who consider math as valuable, end up getting fewer marks on the achievement test. This can be due to the anxiety factor as high value could make students more conscious of the importance of the domain thus can raise their test anxiety (Meece, Wigfield, & Eccles, 1990). This aspect was not investigated in the present study and is recommended for consideration in later studies.

Like utility value, the students in the US have high and significantly different mean value for self-concept. Also, its contribution to math achievement is observably low in the US (Figure 5). This can be due to the culture of individualist societies in which

individuals look into themselves for developing a perception of self. This 'look inside' results in inflated self-perceptions which are not grounded in reality (Triandis, 1995) thU.S. students who think they are good at math do not perform as well on math achievement test.

To understand self-concept of students in the US further, the present study investigated the relationship of self-concept with science achievement and peer achievement. Peer achievement contributes positively to math self-concept. This result is different from the five other countries in the sample, and from other empirical studies (i.e., Chiu, 2012). Also, it does not match with Marsh's assumption that peer achievement contributes negatively to self-concept (Marsh, 1986). However, Marsh provides ground for this positive relationship in his explanation of contrast and assimilation processes in internal/external referencing. In external referencing, if students consider themselves similar to the peers, they take peer achievement positively (Moller & Marsh, 2013). In the study this positive intake has been found in the US only, thus the question arises that why the students in the US only believe in this similarity.

To respond to this question, an insight into the US education system in relation to the US culture is made. In the US, the states set the education policy and the district offices run the schools. The federal government makes suggestions such as The Common Core Standards in math and languages, which were introduced in 2010 to standardize learning in classrooms but are implemented in 43 out of 50 states. Thus presently, schools in 43 states have national standards in two domains while those in 4 states have none to compare teaching and learning. Those 43 states are at different stages of implementation

of these standards. This sparse presence of standards is expected to lead to greater variation in teaching and learning in the country.

Secondly, 90% of the students go to public schools (Snyder, de Brey, & Dillow, 2016). These schools are open to the locals. The US society offers heterogeneity in terms of ethnicity and race, and these characteristics are interlinked to social class (Markus, 2017). People especially from lower-middle and lower social classes prefer to stay within "tight networks of sociability" (Lamont, 2000). Thus, the US society is structured with social and ethnic homogeneity within an area and their heterogeneity across the areas. The public schools are for the locals thus this trend of the society is observed in the student population. The students in a school know that their peers are socially and culturally similar to them. Thirdly, the education district offices rank their schools based on student achievement and offer this information to the public. Thus, students know that their peers are like them socially and culturally. They also know if they are going to a high-achieving or a low-achieving school. What they do not know, however, are the absolute standards to compare their achievement.

Going back to the significant positive input of peer achievement to self-concept, the students in low-performing school have a low perception of their ability in math. Similarly, the students in high-performing school have a high perception of their ability in math. It appears that the students believe that they are similar to their peers. They operate in silos without any absolute standard thus their perception is inflated (Table 3).

***Singapore.***

Singapore is the top-ranked country on TIMSS 2015 math achievement test thus it would be beneficial to understand self-concept and motivation of students in this country.

First, let us look at culture, political, and social systems in the country. Singapore is a city-state, which got independence from the British Empire in 1963. It is a high-tech place, which is ranked number three in the Human Development Index by the United Nations. Most of the citizens are of Chinese-origin, however, 40% of the population lives in the country temporarily with a work permit, instead of a citizenship. Singapore is the only East Asian country in the sample where English is the first language. In other countries, the native language is the first language.

Moving to self-concept and motivation in Singapore, first, the mean values of students in Singapore are closer to those in the US (Table 3). These mean values do not overlap with that of any East Asia country (Table 6). Second, there is a similarity in Singapore and the US in the relationship of self-concept and motivation with achievement (Figure 5). These results indicate that self-concept and motivation of students in Singapore are similar to those in the US, in comparison to the countries geographically close to it.

Sternberg (2017) mentions latest trends in culture including less sharing of culture in geographically close countries and the existence of nonporous borders of some cities and countries. These two trends give some explanation of why students in this city-state are different from those in the neighboring Confucius countries. Its geographical boundaries are wide open to internationals (40% population with work-permit) while the cultural boundaries are nonporous to the Confucius culture in the adjustment countries.

The similarity in Singapore and the US can be explained by the finding of Greenfield (2017) that in urbanized places, such as Singapore, culture becomes more independence-oriented. This independence is a characteristic of individualist cultures like

the US (Triandis, 2015) Thus, there are similarities in self-concept and motivation of students in both these countries. However, there are wide differences in the education system in the two countries. In the US, the states determine curriculum and the districts run the schools. In Singapore, the federal government implements national curriculum and national examinations. The schools in the US offer admission to the locals while in Singapore there are four different school systems after elementary classes with different requirements for student skills and level of knowledge. With these system-level differences and others, the students in the US and in Singapore have wide differences in academic achievement. Due to its top-ranked student achievement and its increasing urbanization and individualism, Singapore can be looked up to find ways to improve the moderate student achievement in the US.

***Japan and Korea.***

One surprising finding of the present study is the negative relationship of intrinsic value with math achievement in Japan and Korea. This finding contrasts with the positive input suggested in Eccles and Wigfield's model of EVT and to the empirical findings in support of the theoretical suggestion (i.e., Zhu, & Leung, 2011). The school system in both the countries is centralized with a national curriculum. These two countries are composed of islands and are located next to each other. Korea remained a colony of Japan for 150 years before the Second World War thus they share history. The first languages in Japan and Korea are rooted in Mandarin (the Chinese language). Unlike city-states of Hong Kong and Singapore, these are proper countries with strong bonding to the Confucius culture. External pressure is one of the characteristics of this culture (Triandis, 2001), which is reflected in cram schools in these countries. These schools

operate daily in addition to the regular school. The main purpose of these schools is to prepare the students for the exams through cramming, and are, therefore, called “cram schools”. Tools such as these schools enable the students to score high but learning becomes tiresome, therefore less interesting.

**Limitations of the Present Study**

The present study was an observational study. Secondly, the students responded to the questionnaire comprising items on self-concept and motivation on the day they took the achievement test, thus the study cannot claim that student’s perceptions of self and motivation were formed before they performed on their test. For these reasons, it cannot propose causal relationships.

The scales used in the study were developed by TIMSS to measure students’ confidence in math, and their likening and perceived value of math. In the study, these scales are used to represent self-concept, intrinsic value, and utility value for math (i.e., Liou, 2017; Marsh et al., 2014), however these scales were not developed by TIMSS to measure these constructs. This fact limits the study from theoretical testing of Eccles and Wigfield’s model, still it provides some insights on students’ self-concept and motivation in the countries in the sample.

Mean scores of students in the US and those in East Asia on the TIMSS 2015 achievement test are very different. Therefore, students in these two places experience peers with different levels of academic competence. This difference in the company can cause a difference in how external referencing, peer achievement, influences self-concept. Peer influence is explored in depth in Big-Fish-Little-Pound effect (Marsh & Craven, 2002). Particularly it sheds light on the positive impact of peer achievement in

assimilation process of the comparison when students take themselves equal to peers. The author is interested to investigate it further.

The focus of the study was a cultural explanation of the achievement gap between the middle school students in the US and those in East Asia. To take countries in East Asia as a group, it relied on Hofstede's (1980) list of countries in individualist and collectivist cultures, which was made 27 years back. Since then, countries with Confucius culture are continuously referred with collectivist characteristic (i.e. in Markus & Kityama, 1991; Triandis, & Gelfand, 2012). However social change is constant (Greenfield, 2017) thus in 2017 some of these countries might have deviated from the Confucius culture. Variance in results within East Asia in the present study indicates towards that deviation.

Lastly, the US is a country of diversity. The variation in ethnicity does bring variation in student motivation within the US (Ford, n.d.). Treating the students in the US as one group overshadows such differences.

**Suggestions for Future Research**

The results of the present study require further investigation of two findings in the US: the negative relationship of utility value with math achievement and the positive relationship of peer achievement with self-concept. Both these results do not match with the related theories and are different from the other five countries. Taking Greenfield's (2017) suggestion of using such different findings to investigate things further and deeper, the present study recommends to further analyze these relationships. One way to do that analysis is to look for the differences among different achievement and ethnic groups of students within the US. The flatter distribution (Table 3). Secondly, Markus

(2017) indicates the existence of both individualist (middle class) and collectivist (working class) groups within the country. It would be interesting to see how the two relationships operate across these two groups. A third way is to check the moderation of anxiety in the relationship of utility and math achievement. Fourthly, the similarities in results in Singapore and US and the former's position as the top-performing country on TIMSS 2015 test encourage to investigate these relationships across different social and achievement groups in these two countries and to compare the findings from the two countries.

Another finding to probe is the insignificant relationship of intrinsic and utility value with math achievement in Chinese Taipei. It has the lowest and significantly different mean value for utility value and its low intrinsic value is only similar to Japan. So, the students do not value math and their evaluation of math's importance and enjoyment in it does not matter to their scores on the achievement tests. This disassociation triggers interest in exploration for effective motivation factors for this population of middle school students.

Lastly, the present study recommends investigating the negative relationship of utility value in Japan and Korea. It suggests checking the moderation of cultural, social, and education principles and practices for that particular research.

**Conclusion**

The present study was aimed to understand the moderate math achievement of middle school students in the US on international tests of achievement. I investigated math achievement gap between the middle school students in the US and those in the top-performing countries in East Asia. The theoretical framework comprised of intrapersonal

factors of motivation and self-concept, interpersonal factor of peer achievement, and contextual factor of culture. I used Eccles and Wigfield's model of expectancy-value theory (Eccles, 1983, Eccles & Wigfield, 2002), Marsh' internal/external frame of reference for self-concept (1986), and Triandis' (1995) individualism/collectivism conception of culture as the main theories for analysis.

I used a subset of TIMSS (Trends in International Mathematics and Science Study) 2015 data of 36,115 middle school students in Chinese Taipei (Taiwan), Hong Kong, Japan, Korea, Singapore, and the US. I used One-Way ANOVA test and structural equation modeling to investigate the difference in science achievement, peer achievement, math self-concept, intrinsic value and utility value of math and their influence on math achievement. The results were interpreted taking a relativist position to find differences in the two cultural groups.

The results inform that in the US, peer achievement is linked differently to self-concept; self-concept and utility value have high mean values; association of these constructs with achievement is observably weak or negative. These results indicate that middle school students in the US do not believe in competition with peers; they think highly of themselves and of the domain; their perception of self is comparatively linked weakly to achievement; and the U.S. students who value math more, score low on achievement exams. These student characteristics associate with the moderate achievement of students in the US. The study recommends investigating these findings further. In particular, by including the school effect in the ANOVA as the potential external horizon for these young respondents and secondly giving increased weight to the differences in s.d. which should be associated with the individual/group referent of the

American/Confucian contrast by a greater focus on effect size rather than statistical significance.

## References


Abu-Hilal, M. M., Abdelfattah, F. A., Shumrani, S. A., Dodeen, H., Abduljabber, A. S., & Marsh, H. W. (2014). Mathematics and science achievements predicted by self-concept and subject value among 8th grade Saudi students: Invariance across gender. *International Perspectives in Psychology: Research, Practice, Consultation, 3*(4), 268-283. doi:10.1037/ipp0000022

Ainur, A. K., Sayang, M. D., Jannoo, Z., & Yap, B. W. (2017). Sample size and non-normality effects on goodness of fit measures in structural equation models. *Pertanika Journal of Science & Technology, 25*(2), 575-586. Retrieved from https://uitm.pure.elsevier.com/

Akyuz, G., & Bilim. E.V. (2014). The effects of student and school factors on mathematics achievement in TIMSS 2011. *Education and Science, 39*(172), 150-162. Retrieved from http://link.springer.com/journal/11191

Atkinson, J. W. (1957). Motivational determinants of risk-taking behavior. *Psychological Review, 64(*6,1), 359-372. doi:10.1037/h0043445

Atkinson, J. W. (1964). *An introduction to motivation*. Princeton, N.J: Van Nostrand.

Bandura, A. (1978). The self system in reciprocal determinism. *American Psychologist, 33*(4), 344-358. doi:10.1037/0003-066X.33.4.344

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Bempechat, J., & Drago-Severson, E. (1999). Cross-national differences in academic achievement: Beyond etic conceptions of children's. *Review of Educational Research*, *69*(3), 287-314. Retrieved from http://www.jstor.org/stable/1170541

Bergin, D. A., Ford, M. E., & Hess, R. D. (1993). Patterns of motivation and social behavior associated with microcomputer use of young children. *Journal of Educational Psychology*, *85*(3), 437-445. doi:10.1037/0022-0663.85.3.437

Berndt, A. E., & Williams, P. C. (2013). Hierarchical regression and structural equation modeling: two useful analyses for life course research. *Family and Community Health*, 36(1), 4-18. doi: 10.1097/FCH.0b013e31826d74c4

Berry, J. W., & Dasen, P. R. (1974). *Culture and cognition: Readings in cross-cultural psychology.* London: Methuen.

Bronfenbrenner, U. (1995). Developmental ecology through space and time: A future perspective. In P. Moen, G. J. Elder, K. Lüscher, P. Moen, G. J. Elder, K. Lüscher (Eds.), *Examining lives in context: Perspectives on the ecology of human*

*development* (pp. 619-647). Washington, DC, US: American Psychological Association. doi:10.1037/10176-018

Byrne, B. M. (1984). The general/academic self-concept nomological network: A review of construct validation research. *Review of Educational Research, 54*(3), 427-456. Retrieved from http://www.jstor.org/stable/1170455

Byrne, B. M. (1986). Self-concept/academic achievement relations: An investigation of dimensionality, stability, and causality. *Canadian Journal of Behavioural Science / Revue Canadienne Des Sciences Du Comportement, 18*(2), 173-186. doi:10.1037/h0079982

Ceylan, E., & Akerson, V. (2017). Comparing the low- and high-performing schools based on the TIMSS in the United States. *Egitim Ve Bilim-Education and Science, 39(*173), 299-309. Retrieved from https://www.researchgate.net/publication/

Chen, J. (2011). *An evaluation of the relationship between classroom practices and mathematics motivation from student and teacher perspectives* (Doctoral dissertation). Retrieved from ProQuest Dissertations & Theses Global. (Order No. 3433562)

Chiu, M. (2008). Achievements and self-concepts in a comparison of math and science: Exploring the internal/external frame of reference model across 28 countries. *Educational Research and Evaluation, 14*(3), 235-254. doi:10.1080/13803610802048858

Chiu, M. (2012). The internal/external frame of reference model, big-fish-little-pond effect, and combined model for mathematics and science. *Journal of Educational Psychology, 104*(1), 87-107. doi:10.1037/a0025734

Cho, E., & Kim, S. (2015). Cronbach's Coefficient Alpha: Well-known but poorly understood. *Organizational Research Methods*, *18*(2), 207-230. doi:10.1177/1094428114555994

Choi, K., Choi, T., & McAninch, M. (2012). A comparative investigation of the presence of psychological conditions in high achieving eighth graders from TIMSS 2007 Mathematics. *Zdm Mathematics Education, 44*(2), 189-199. doi:10.1007/s11858-012-0401-6

Chow, A., Eccles, J. S., & Salmela-Aro, K. (2012). Task value profiles across subjects and aspirations to physical and IT-related sciences in the United States and Finland. *Developmental Psychology*, *48*(6), 1612-1628. doi:10.1037/a0030194

Cogan, L. S., Schmidt, W. H., & Wiley, D. E. (2001). Who takes what math and in which track? Using TIMSS to characterize U.S. students' eighth-grade mathematics learning opportunities. *Educational Evaluation and Policy Analysis*, *23*(4). 323-341. Retrieved from http://www.jstor.org/stable/3594133

Cooley, C. H. (1902). *Human nature and the social order*. New York: Scribner's.

Cortina, J. M. (1993). What is Coefficient Alpha? An examination of theory and applications. *Journal of Applied Psychology, 78*(1), 98-104. doi: 10.1037/0021-9010.78.1.98

Deci, E. L., & Ryan, R. M. (1985). The general causality orientations scale: Self-determination in personality. *Journal of Research in Personality, 19*(2), 109-134. doi:10.1016/0092-6566(85)90023-6

Durik, A. M., Vida, M., & Eccles, J. S. (2006). Task values and ability beliefs as predictors of high school literacy choices: A developmental analysis. *Journal of Educational Psychology, 98*(2), 382-393. doi:10.1037/0022-0663.98.2.382

Dyson, L. (2015). In the convergence of ethnicity and immigration: The status and socio-ecological predictors of the self-concept of recent Chinese immigrant school-age children in Canada. *Journal of Child and Family Studies, 24*(1), 1-11. doi:10.1007/s10826-013-9808-0

Eccles, J. S. (1983). Expectancies, values, and academic behaviors. In J. T. Spencer (Ed.), *Achievement and achievement motives* (pp.75-146). San Francesco: Freeman.

Eccles, J. S. (2005). Subjective task value and the Eccles et al. model of achievement-related choices. In A. J. Elliot, C. S. Dweck, A. J. Elliot, & C. S. Dweck (Eds.), *Handbook of competence and motivation* (pp. 105-121). New York, NY, US: Guilford Publications.

Eccles, J. S., & Wigfield, A. (1995). In the mind of the actor: The structure of adolescents' achievement task values and expectancy-related beliefs. *Personality and Social Psychology Bulletin, 21*(3), 215-225. doi:10.1177/0146167295213003

Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual Review of Psychology, 53*(1), 109-132. doi:10.1146/annurev.psych.53.100901.135153

Eccles, J., Wigfield, A., Harold, R. D., & Blumenfeld, P. (1993). Age and gender differences in children's self- and task perceptions during elementary school. *Child Development, 64*(3), 830-847. doi:10.2307/1131221

Eccles, J. S., Wigfield, A., Flanagan, C. A., Miller, C., Reuman, D. A., & Yee, D. (1989). Self-concepts, domain values, and self-esteem: Relations and changes at early adolescence. *Journal of Personality, 57*(2), 283-310. doi:10.1111/j.1467-6494.1989.tb00484.x

Eccles, J. S., Wigfield, A., & Schiefele, U. (1998). Motivation to succeed. In N. Eisenberg, & N. Eisenberg (Eds.), *Handbook of child psychology, social, emotional, and personality* (5th ed., Vol. 3, pp. 46-79) NJ, US: John Wiley & Sons In.

Eklöf, H. (2007). Self-concept and valuing of mathematics in TIMSS 2003: Scale structure and relation to performance in a Swedish setting. *Scandinavian Journal of Educational Research, 51*(3), 297-313. doi:10.1080/00313830701356141

Elliot, A.J., & McGregor, H.A. (2001). A 2 X 2 Achievement goal framework. *Journal of Personality and Social Psychology, 80* (3), 501-519. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/11300582

Feather, N. T. (1988). From values to actions: Recent applications of the expectancy-value model. *Australian Journal of Psychology, 40*(2), 105-124. doi:10.1080/00049538808259076

Ford, J. (n.d.) *Revising Middleton's model of mathematics achievement and exploring ethnic differences across white, black, and Hispanic adolescents* (Doctoral dissertation). (in process). The University of Memphis, Memphis.

Foy, P., & LaRoche, S. (2016). Estimating standard errors in the TIMSS 2015 results. In M. O. Martin, I. V. S. Mullis, & M. Hooper (Eds.), *Methods and procedures in TIMSS 2015* (pp. 4.1-4.69). Retrieved from Boston College, TIMSS & PIRLS International Study Center website: http://timss.bc.edu

Garrido, L. E., Abad, F. J., & Ponsoda, V. (2016). Are fit indices really fit to estimate the number of factors with categorical variables? Some cautionary findings via Monte Carlo simulation. *Psychological Methods*, *21*(1), 93-111. doi:10.1037/met0000064

Garson, G. D. (2015). *Missing values analysis and data imputation*. Asheboro, NC: Statistical Associates Publishers.

Gelfand, M. J., Raver, J. L., Nishii, L., Leslie, L. M., Lun, J., Lim, B. C., ... Yamaguchi, S. (2011). Differences between tight and loose cultures: A 33-nation study. *Science, 332*(6033), 1100-1104. doi:10.1126/science.1197754

Graham, S., & Weiner, B. (1996). Theories and principles of motivation. In D. C. Berliner, R. C. Calfee, D. C. Berliner, R. C. Calfee (Eds.), *Handbook of educational psychology* (pp. 63-84). New York, NY: Macmillan Library Reference USA.

Greenfield, P. M. (2017). Cultural change over time: Why replicability should not be the gold standard in psychological science. *Perspectives on Psychological Science*, *12*(5), 762-771. doi:10.1177/1745691617707314

Guo, J., Marsh, H. W., Parker, P. D., Morin, A. J., & Dicke, T. (2017). Extending expectancy-value theory predictions of achievement and aspirations in science: Dimensional comparison processes and expectancy-by-value interactions. *Learning and Instruction*, 4, 981-991. doi:10.1016/j.learninstruc.2016.12.007

Guo, J., Parker, P. D., Marsh, H. W., & Morin, A. S. (2015). Achievement, motivation, and educational choices: A longitudinal study of expectancy and value using a multiplicative perspective. *Developmental Psychology, 51*(8), 1163-1176. doi:10.1037/a0039440

Gustafsson, J., Nilsen, T., & Hansen, K. Y. (2016). School characteristics moderating the relation between student socio-economic status and mathematics achievement in grade 8. Evidence from 50 countries in TIMSS 2011. *Studies in Educational Evaluation*, *6*(12). doi:10.1016/j.stueduc.2016.09.004

Haichun, S., Haiyong, D., & Ang, C. (2013). Nothing but being there matters: Expectancy-value motivation between U.S. and Chinese middle school students. *International Education*, *42*(2), 7-20. Retrieved from: http://trace.tennessee.edu/internationaleducation/vol42/iss2/2

Hamamura, T., & Heine, S. J. (2008a). Approach and avoidance motivation across cultures. In A. J. Elliot, A. J. Elliot (Eds.), *Handbook of approach and avoidance motivation* (pp. 557-570). New York, NY, US: Psychology Press.

Hamamura, T., & Heine, S. J. (2008b). The role of self-criticism in self-improvement and face maintenance among Japanese. In E. C. Chang, E. C. Chang (Eds.), *Self-criticism and self-enhancement: Theory, research, and clinical implications* (pp. 105-122). doi:10.1037/11624-007

Harkness, S., & Keefer, C. H. (2000). Contributions of cross-cultural psychology to research and interventions in education and health. *Journal of Cross-Cultural Psychology*, *31*(1), 92-109. doi:10.1177/0022022100031001008

Harter, S. (1986). Cognitive-developmental processes in the integration of concepts about emotions and the self. *Social Cognition,4*(2), 119-151. doi:10.1521/soco.1986.4.2.119

Harter, S. (2012). Emerging self-processes during childhood and adolescence. In M. R. Leary, J. P. Tangney, M. R. Leary, J. P. Tangney (Eds.), *Handbook of self and identity* (2nd ed., pp. 680-715). New York, NY: Guilford Press.

Hattie, J. (2009). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement*. London: Routledge.

Hau, K., Kong, C., Marsh, H. W., & Cheng, Z. (2000). Extension of the internal/external frame of reference model of self-concept formation: Importance of native and nonnative languages for Chinese students. *Contemporary Educational Psychology*, *39*(4), 326-341. doi:10.1016/j.cedpsych.2014.08.003

Helmke, A., & Tuyet, V. A. (1999). Do Asian and western students learn in different way? An empirical study on motivation, study time, and learning strategies of German and Vietnamese university students. *Asia Pacific Journal of Education*, *19*(2), 30. doi:10.1080/0218879990190204

Herskovits, M. J. (1948*). Man and his works: The science of cultural anthropology*. New York: Knopf.

Hilgard, E. R. (1949). Human motives and the concept of the self. *American Psychologist, 43*, 73-382.

Hilton, M. (2008). Skills for work in the 21st century: What does the research tell us? *The Academy of Management Perspectives, 22*(4), 63-78. Doi: 10.5465/AMP.2008.35590354

Hinkle, D. E., Wiersma, W., & Jurs, S. G. (2003). *Applied statistics for the behavioral sciences*. Boston, Mass: Houghton Mifflin.

Hofstede, G. (1984). *Culture's consequences: International differences in work-related values*. Beverly Hills: Sage Publications.

House, J. D. & Telese, J. A. (2015). Engagement in science lessons and achievement test scores of eighth-grade students in Korea: findings from the TIMSS 2011 assessment. *Education, 135*(4), 435-438. Retrieved from *http://www.projectinnovation.biz/education.html*

House, J. D. (2006). Cognitive-motivational characteristics and geometry knowledge of adolescent students in Japan: Results from the TIMSS 1999 assessment. *International Journal of Instructional Media, 33*(1), 169-179. Retrieved from http://www.adprima.com/ijim.htm

House, J. D. (2008). Science beliefs, instructional strategies, and life sciences achievement of adolescent students in Japan: Results from the TIMSS 1999 assessment. *International Journal of Instructional Media, 33*(4), 443-462. Retrieved from http://www.adprima.com/ijim.htm

House, J. D. (2009). Mathematics beliefs and achievement of a national sample of native American students: Results from the Trends in International Mathematics and Science Study (TIMSS) 2003 United States assessment. *Psychological Reports, 104*(2), 439-446. doi:10.2466/PR0.104.2.439-446

Hoyle, R. H., & Isherwood, J. C. (2013). Reporting results from structural equation modeling analyses. *Archives of Scientific Psychology, 1*(1), 14-22. doi:10.1037/arc0000004

Hsu, E L. K. (1972). *Psychological anthropology*. Cambridge, MA: Schenkman.

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*(1), 1-55. doi:10.1080/10705519909540118

Hughes, C. (2011). The influence of self-concept, parenting style and individualism–collectivism on career maturity in Australia and Thailand. *International Journal*

*for Educational and Vocational Guidance*, *11*(3), 197-210. doi:10.1007/s10775-011-9208-1

Huguet, P., Dumas, F., Monteil, J. M., & Genestoux, N. (2001). Social comparison choices in the classroom: Further evidence for students' upward comparison tendency and its beneficial impact on performance. *European Journal of Social Psychology*, *31*(5), 557-578. doi:10.1002/ejsp.81

Hull, C.L. (1943). *Principles of behavior, an introduction to behavior theory***.** New York: Appleton-Century-Crofts.

Hwang, K. (2015). Culture-Inclusive theories of self and social interaction: The approach of multiple philosophical paradigms. *Journal for The Theory of Social Behaviour*, *45*(1), 40-63. doi:10.1111/jtsb.12050

Ing, M. (2014). Can parents influence children's mathematics achievement and persistence in STEM careers? *Journal of Career Development*, *41*(2), 87-103. doi:10.1177/0894845313481672

Iwasa, N. (1989). *Situational considerations in moral judgment: A japan-united states comparison* (Doctoral dissertation). Retrieved from ProQuest Dissertations & Theses Global (Order No. 9000862)

James W. Stigler, A., Sheila Smith, A., & Lian-Wen Mao, A. (1985). The self-perception of competence by Chinese children. *Child Development*, (5), 1259-1270. doi:10.2307/1130241

James, W. (1890). *The principles of psychology*. doi:10.1037/11059-000

Johansone, I. (2016). Survey operations procedures in TIMSS 2015. In M. O. Martin, I. V. S. Mullis, & M. Hooper (Eds.), *Methods and procedures in TIMSS 2015* (pp. 6.1-6.22). Retrieved from Boston College, TIMSS & PIRLS International Study Center website: http://timss.bc.edu

Joncas, M. (2008). TIMSS 2007 Sample design. In Olson, J.F., Martin, M.O., & Mullis, I.V.S. (Eds.), *TIMSS 2007 technical report* (pp. 77-92). Retrieved from Boston College, TIMSS & PIRLS International Study Center website: http://timssandpirls.bc.edu

Kagitcibasi, C. (2000). (Cross) cultural psychology. In K. Pawlik, M. R. Rosenzweig, K. Pawlik, M. R. Rosenzweig (Eds.), *International handbook of psychology* (pp. 328-346). Thousand Oaks, CA: Sage Publications Ltd.

Kaya, S. (2008). *The effects of student-level and classroom-level factors on elementary students' science achievement in five countries* (Doctoral dissertation). Retrieved from ProQuest Dissertations & Theses Global. (Order No. 3348503)

Ker, H. (2016). The impacts of student-, teacher- and school-level factors on mathematics achievement: an exploratory comparative investigation of Singaporean students and the USA students. *Educational Psychology, 36*(2), 225-250. doi:10.1080/01443410.2015.1026801

Ker, H. (2017). The effects of motivational constructs and engagements on mathematics achievements: a comparative study using TIMSS 2011 data of Chinese Taipei, Singapore, and the USA. *Asia Pacific Journal of Education, 37*(2), 135-149. doi:10.1080/02188791.2016.1216826

Kilic, S., & Askin, Ö. E. (2013). Parental influence on students' mathematics achievement: The comparative study of Turkey and best performer countries in TIMSS 2011. *Procedia - social and behavioral sciences, 106*(4th International Conference on New Horizons in Education), 2000-2007.

Kline, R. B. (2011). *Principles and practice of structural equation modeling*. New York: Guilford Press.

Kraft, M. A., Marinell, W. H., & Shen-Wei Yee, D. (2016). School organizational contexts, teacher turnover, and student achievement. *American Educational Research Journal, 53*(5), 1411-1449. Doi: 10.3102/0002831216667478

Lamont, M. (2000). *The dignity of working men: Morality and the boundaries of race, class, and immigration*. New York: Russell Sage Foundation.

LaRoche, S., Joncas, M., & Foy, P. (2016). Sample design in TIMSS 2015. In M. O. Martin, I. V. S. Mullis, & M. Hooper (Eds.), *Methods and procedures in TIMSS 2015* (pp. 3.1-3.37). Retrieved from Boston College, TIMSS & PIRLS International Study Center website: http://timss.bc.edu

Lee, J., Lee, M., & Bong, M. (2013). High value with low perceived competence as an amplifier of self-worth threat. In D. M. McInerney, H. W. Marsh, R. G. Craven, F. Guay, D. M. McInerney, H. W. Marsh, ... F. Guay (Eds.), *Theory driving research: New wave perspectives on self-processes and human development* (pp. 205-231). Charlotte, NC: IAP Information Age Publishing.

Lindenberg, S. (2001). Intrinsic motivation in a new light. *Kyklos, 5*(4), 317–342. **Doi:** 10.1111/1467-6435.00156

Liou, P. (2010). *Cross-national comparisons of the association between student motivation for learning mathematics and achievement linked with school contexts: Results from TIMSS 2007.* Retrieved from https://search.proquest.com/docview/738330890?accountid=14582 (Order No. 3411857).

Liou, P. (2017). Profiles of adolescents' motivational beliefs in science learning and science achievement in 26 countries: Results from TIMSS 2011 data.

*International Journal of Educational Research, 8*(1), 83-96. doi:10.1016/j.ijer.2016.11.006

Liou, P., & Liu, E. Z. (2015). An analysis of the relationships between Taiwanese eighth and fourth graders' motivational beliefs and science achievement in TIMSS 2011. *Asia Pacific Education Review, 16*(3), 433-445. doi:10.1007/s12564-015-9381-x

Liu, S., & Meng, L. (2010). Re-Examining factor structure of the attitudinal items from TIMSS 2003 in cross-cultural study of Mathematics self-concept. *Educational Psychology, 30*(6), 699-712. Doi:10.1080/01443410.2010.501102

Lun, V. M., Fischer, R., & Ward, C. (2010). Exploring cultural differences in critical thinking: Is it about my thinking style or the language I speak? *Learning and Individual Differences*, *20*(6), 604-616. doi:10.1016/j.lindif.2010.07.00

Luttrell, V. R., Callen, B. W., Allen, C. S., Wood, M. D., Deeds, D. G., & Richard, D. S. (2010). The Mathematics value inventory for general education students: Development and initial validation. *Educational and Psychological Measurement, 70*(1), 142-160. doi:10.1177/0013164409344526

Markus, H. R., & Kitayama, S. (1992). The what, why and how of cultural psychology: A review of shweder's thinking through cultures. *Psychological Inquiry*, *3*(4), 357-364. Retrieved from http://www.jstor.org/stable/1448997

Markus, H. R., & Kitayama, S. (2010). Cultures and selves: A cycle of mutual constitution. *Perspectives on Psychological Science*, *5*(4), 420-430. Doi: 10.1177/1745691610375557

Marsh, H. W. (1986). Verbal and math self-concepts: An internal/external frame of reference model. *American Educational Research Journal, 23*(1), 129-149. doi:10.2307/1163048

Marsh, H. W., & Craven, R. G. (2002). *The pivotal role of frames of reference in academic self-concept formation: The "Big Fish-Little Pond" Effect.* Greenwich, UK: Information Age Publishing, Inc.

Marsh, H. W., & Hau, K. (2003). Big-Fish-Little-Pond effect on academic self-concept: A cross-cultural (26-country) test of the negative effects of academically selective schools. *American Psychologist, 58*(5), 364-376. doi:10.1037/0003-066X.58.5.364

Marsh, H. W., & Yeung, A. S. (2001). An extension of the internal/external frame of reference model: A response to Bong (1998). *Multivariate Behavioral Research, 36*(3), 389-420. doi:10.1207/S15327906389-420

Marsh, H. W., Abduljabbar, A. S., Parker, P. D., Morin, A. S., Abdelfattah, F., & Nagengast, B. (2014). The Big-Fish-Little-Pond effect in mathematics: A cross-

cultural comparison of U.S. and Saudi Arabian TIMSS responses. *Journal of Cross-Cultural Psychology, 45*(5), 777-804. doi:10.1177/0022022113519858

Marsh, H. W., Abduljabbar, A. S., Parker, P. D., Morin, A. S., Abdelfattah, F., Nagengast, B., Moller, J., & Abu-Hilal, M. M. (2015). The internal/external frame of reference model of self-concept and achievement relations: Age-cohort and cross-cultural differences. *American Educational Research Journal, 52*(1), 168-202. doi:10.3102/0002831214549453

Marsh, H. W., Byrne, B. M., & Shavelson, R. J. (1988). A multifaceted academic self-concept: Its hierarchical structure and its relation to academic achievement. *Journal of Educational Psychology, 80,* 366–380. doi:10.1037/0022-0663.80.3.366

Marsh, H. W., Hau, K., & Kong, C. (2002). Multilevel causal ordering of academic self-concept and achievement: Influence of language of instruction (English compared with Chinese) for Hong Kong students. *American Educational Research Journal, 39*(3), 727-763. doi:10.3102/00028312039003727

Marsh, H. W., Kong, C., & Hau, K. (2000). Longitudinal multilevel models of the big-fish-little-pond effect on academic self-concept: Counterbalancing contrast and reflected-glory effects in Hong Kong schools. *Journal of Personality and Social Psychology, 78*(2), 337-349. doi:10.1037/0022-3514.78.2.337

Marsh, H. W., Kong, C., & Hau, K. (2001). Extension of the internal/external frame of reference model of self-concept formation: Importance of native and nonnative languages for Chinese students. *Journal of Educational Psychology, 93*(3), 543-553. doi:10.1037/0022-0663.93.3.543

Marsh, H. W., Seaton, M., Trautwein, U., Lüdtke, O., Hau, K. T., O'Mara, A. J., & Craven, R. G. (2008). The big-fish-little-pond-effect stands up to critical scrutiny: Implications for theory, methodology, and future research. *Educational Psychology Review, 20*(3), 319-350. doi:10.1007/s10648-008-9075-6

Marsh, H. W., Trautwein, U., Lüdtke, O., Baumert, J., & Köller, O. (2007). The big-fish-little-pond effect: Persistent negative effects of selective high schools on self-concept after graduation. *American Educational Research Journal, 44*(3), 631-669. doi:10.3102/0002831207306728

Martin, M. O., Mullis, I. V. S., Hooper, M., Yin, L., Foy, P., & Palazzo, L. (2016). Creating and interpreting the TIMSS 2015 context questionnaire scales. In M. O. Martin, I. V. S. Mullis, & M. Hooper (Eds.), *Methods and procedures in TIMSS 2015* (pp. 15.1-15.312). Retrieved from Boston College, TIMSS & PIRLS International Study. website: http://timss.bc.edu

Marx, M. (1960). Motivation. In C.W. Harris (Ed.) Encyclopedia of educational research (3rd ed., pp. 888-901). New York: Macmillan.

McDonald, R. P., & Ho, M. R. (2002). Principles and practice in reporting structural equation analyses. *Psychological Methods,* 7(1), 64-82. doi:10.1037/1082-989X.7.1.64

Meece, J. L., Wigfield, A., & Eccles, J. S. (1990). Predictors of math anxiety and its influence on young adolescents' course enrollment intentions and performance in mathematics. *Journal of Educational Psychology, 82(1),* 60-70. doi:10.1037/0022-0663.82.1.60

Möller, J., & Marsh, H. W. (2013). Dimensional comparison theory. *Psychological Review, 120*(3), 544-560. doi:10.1037/a0032459

Möller, J., Pohlmann, B., Köller, O., & Marsh, H. W. (2009). A meta-analytic path analysis of the internal/external frame of reference model of academic achievement and academic self-concept. *Review of Educational Research, 79*(3), 1129-1167. doi:10.3102/0034654309337522

Möller, J., Streblow, L., Pohlmann, B., & Köller, O. (2006). An extension to the internal/external frame of reference model to two verbal and numerical domains. *European Journal of Psychology of Education*, *21*, 467–487. doi:10.1007/BF03173515

Mooney, E. S., & Thornton, C. A. (1999). Mathematics attribution differences by ethnicity and socioeconomic status. *Journal of Education for Students Placed at Risk, 4*(3), 321-332. Doi: 10.1207/s15327671espr0403_9

Moriizumi, S. (2011). Constructing multifaceted cultural identity theory: Beyond dichotomization of individualism-collectivism. *China Media Research*, *7*(2), 17-25. Retrieved from http://www.chinamediaresearch.net

Mueller, C. E., & Winsor, D. L. (2016). Math and verbal academic self-concept: Subject-specificity across four distinctive groups of high ability adolescents. *Learning and Individual Differences*, *50,* 240-245. doi:10.1016/j.lindif.2016.08.002

Muenks, K., Miele, D. B., & Wigfield, A. (2016). How students' perceptions of the source of effort influence their ability evaluations of other students. *Journal of Educational Psychology*, *108*(3), 438-454. doi:10.1037/edu0000068

Mullis, I. V. S., Martin, M. O., Foy, P., & Hooper, M. (2016). *TIMSS 2015 international results in mathematics.* Retrieved from Boston College, TIMSS & PIRLS International Study Center website: http://timssandpirls.bc.edu

Mullis, I.V.S., Martin, M.O., Foy, P., & Arora, A. (2012). *TIMSS 2011 international results in mathematics.* Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

Musu-Gillette, L. E., Wigfield, A., Harring, J. R., & Eccles, J. S. (2015). Trajectories of change in students' self-concepts of ability and values in math and college major

choice. *Educational Research and Evaluation, 21*(4), 343-370. doi:10.1080/13803611.2015.1057161

Muthén, L.K. and Muthén, B.O. (1998-2015). *Mplus user's guide*. Seventh Edition. Los Angeles, CA: Muthén & Muthén.

Papanastasiou, C. (2000). Internal and external factors affecting achievement in mathematics: Some findings from TIMSS. *Studies in Educational Evaluation, 26*(1), 1-7. Doi: 10.1016/S0191-491X(00)00002-X

Parker, P., Marsh, H., Ciarrochi, J., Marshall, S., & Abduljabbar, A. (2017). Juxtaposing math self-efficacy and self-concept as predictors of long-term achievement outcomes. *Educational Psychology, 34*(1), 29-48. Doi: 10.1080/01443410.2013.797339

Patnam, V. S. (2013). *Factors related to student achievement in mathematics and comparison of the U.S. with other countries: A study based on TIMSS 2007 report*. (Order No. 3591696). Retrieved from https://search.proquest.com/docview/1434876028?accountid=14582

Pcibasi, C., & Poortinga, Y. H. (2000). Cross-cultural psychology: Issues and overarching themes. *Journal of Cross-Cultural Psychology, 31*(1), 129-147. doi:10.1177/0022022100031001002

Pelto, P. (1968). The differences between 'tight' and 'loose' societies. *Society, 5*(5), 37-40. doi:10.1007/BF03180447

Pitchford, K. D. (2013). *Classroom instructional practices and middle grades mathematics achievement in the U.S.: A secondary analysis of TIMSS 2007 data* (doctoral dissertation). Retrieved from ProQuest Dissertations & Theses Global. (Order No. 3575652).

Provasnik, S., Malley, L., Stephens, M., Landeros, K., Perkins, R., and Tang, J.H. (2016). Highlights from TIMSS and TIMSS Advanced 2015: Mathematics and science achievement of U.S. students in grades 4 and 8 and in advanced courses at the end of high school in an international context (NCES 2017-002). Retrieved from http://nces.ed.gov/pubsearch.

Randel, B., Stevenson, H. W., & Witruk, E. (2000). Attitudes, beliefs, and mathematics achievement of German and Japanese high school students. *International Journal of Behavioral Development, 24*(2), 190. doi:10.1080/016502500383313

Rotter (1966). Generalized expectancies for internal verses external control of reforcement. *Psychological Monographs, 80*(1), 1-28. Doi: 10.1037/h0092976

Salchegger, S. (2015). Selective school systems and academic self-concept: How explicit and implicit school-level tracking relate to the big-fish–little-pond effect across

cultures. *Journal of Educational Psychology, 108*(3), 1-19. doi:10.1037/edu0000063

Sarbin, T. R. (1952). A preface to a psychological analysis of the self. *Psychological Review, 59,* 11-22. Doi:10.1037/h0058279

Sawada, A. D. (1996). Educating hearts and minds: Reflections on Japanese preschool and elementary education. *Monumenta Nipponica, 51*(4), 523-526. doi:10.2307/2385445

Schunk, D. H., Meece, J. L., & Pintrich, P. R. (2014). *Motivation in education, theory, research, and application*. New Jersey: Pearson.

Schütte, K. S. (2015). Science self-concept and valuing science: a cross-cultural analysis of their relation among students from Western and East Asian countries. *Social Psychology of Education, 18*(4), 635-652. Doi:10.1007/s11218-015-9311-0

Segall, M. H., Lonner, W. J., & Berry, J. W. (1998). Cross-cultural psychology as a scholarly discipline: On the flowering of culture in behavioral research. *American Psychologist, 53*(10), 1101-1110. doi:10.1037/0003-066X.53.10.1101

Shavelson, R. J., & Bolus, R. (1982). Self concept: The interplay of theory and methods. *Journal of Educational Psychology, 74*(1), 3-17. doi:10.1037/0022-0663.74.1.3

Shavelson, R. J., Hubner, J. J., & Stanton, G. C. (1976). Self-concept: Validation of construct interpretations. *Review of Educational Research, 46*(3), 407-441. doi:10.2307/1170010

Shen, C., & Tam, H. P. (2008). The paradoxical relationship between student achievement and self-perception: A cross-national analysis based on three waves of TIMSS data. *Educational Research and Evaluation, 14*(1), 87-100. doi.org/10.1080/13803610801896653

Skaalvik, E. M., & Hagtvet, K. A. (1990). Academic achievement and self-concept: An analysis of causal predominance in a developmental perspective. *Journal of Personality and Social Psychology,* 58(2), 292-307. doi:10.1037/0022-3514.58.2.292

Snyder, T.D., de Brey, C., & Dillow, S.A. (2016). Digest of education statistics 2015 (NCES 2016-014). Washington, DC: National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education.

Spence, K. W. (1958). A theory of emotionally based drive (D) and its relation to performance in simple learning situations. *American Psychologist, 13*(4), 131-141. doi:10.1037/h0045054

Stankov, L. (2010). Unforgiving Confucian culture: A breeding ground for high academic achievement, test anxiety and self-doubt? *Learning and Individual Differences, 20,* 555-563. doi:10.1016/j.lindif.2010.05.003

Sternberg, R. J. (2017). Some lessons from a symposium on cultural psychological science. *Perspectives on Psychological Science, 12*(5), 911-921. doi:10.1177/1745691617720477

Stevenson, H. W., Lee, S., Chen, C., Lummis, M., Stigler, J., Fan, L., & Ge, F. (1990). Mathematics achievement of children in China and the United States. *Child Development, 61*(4), 1053-1066. doi:10.2307/1130875

Taasoobshirazi, G., & Wang, S. (2016). The performance of the SRMR, RMSEA, CFI, and TLI: An examination of sample size, path size, and degrees of freedom. *Journal of Applied Quantitative Methods*, (3), 31-39. Retrieved from http://www.jaqm.ro/

Tolman, E. (1932). *Purposive behavior in animals and men*. Oxford, England: Appleton-Century.

Tosa, S. (2009). *Teaching science as inquiry in US and in Japan: A cross-cultural comparison of science teachers' understanding of, and attitudes toward inquiry-based teaching* (Doctoral dissertation). Retrieved from ProQuest Dissertations & Theses Global. (Order No. 3361230)

Trautwein, U., Lüdtke, O., Marsh, H. W., Köller, O., & Baumert, J. (2006). Tracking, grading, and student motivation: Using group composition and status to predict self-concept and interest in ninth-grade mathematics. *Journal of Educational Psychology*, (4), 788-806. doi:10.1037/0022-0663.98.4.788

Trautwein, U., Marsh, H. W., Nagengast, B., Lüdtke, O., Nagy, G., & Jonkmann, K. (2012). Probing for the multiplicative term in modern expectancy-value theory: A latent interaction modeling study. *Journal of Educational Psychology, 104*(3), 763-777. doi:10.1037/a0027470

Triandis, H. C. (1995). *Individualism & collectivism*. Boulder, CO: Westview Press.

Triandis, H. (2000). Dialectics between cultural and cross-cultural psychology. *Asian Journal of Social Psychology, 3,* 185-195. doi:10.1111/1467-839X.00063

Triandis, H. C. (2004). The many dimensions of culture. *The Academy of Management Executive (1993-2005), 1*, 88-93. Retrieved from http://www.jstor.org/stable/4166039

Triandis, H. C. (2011). Culture and self-deception: A theoretical perspective. *Social Behavior and Personality, 39*(1), 3-14. doi:10.2224/sbp.2011.39.1.3

Triandis, H. C. (2015). Collectivism and individualism: Cultural and psychological concerns. *International Encyclopedia of the Social & Behavioral Sciences* (2nd ed., Vol. 4). Retrieved from http://dx.doi.org/10.1016/B978-0-08-097086-8.24008-7

Triandis, H. C. (2016). Focusing on culture in psychology. In R. J. Sternberg, S. T. Fiske, D. J. Foss, R. J. Sternberg, S. T. Fiske, D. J. Foss (Eds.), *Scientists making a difference: One hundred eminent behavioral and brain scientists talk about their most important contributions* (pp. 413-416). New York, NY: Cambridge University Press.

Triandis, H. C., & Gelfand, M. J. (2012). A theory of individualism and collectivism. In P. M. Van Lange, A. W. Kruglanski, E. T. Higgins, P. M. Van Lange, A. W. Kruglanski, & E. T. Higgins (Eds.), *Handbook of theories of social psychology* (Vol. 2, pp. 498-520). doi:10.4135/9781446249222.n51

Tylor, E. B. (1924). *Primitive culture: Researches into the development of mythology, philosophy, religion, language, art, and custom* (7th ed., Vol. 1). doi:10.1037/13484-000

Urdan, T., Solek, M., & Schoenfelder, E. (2007). Students' perceptions of family influences on their academic motivation: A qualitative analysis. *European Journal of Psychology of Education, 22*(1), 7-21. doi:10.1007/BF03173686

Valentine, J. C., DuBois, D. L., & Cooper, H. (2004). The relation between self-beliefs and academic achievement: A meta-analytic review. *Educational Psychologist, 39*(2), 111-133. doi:10.1207/s15326985ep3902_3

Wang, J. H., & Guthrie, J. T. (2004). Modeling the effects of intrinsic motivation, extrinsic motivation, amount of reading, and past reading achievement on text comprehension between U.S. and Chinese students. *Reading Research Quarterly, 39*(2), 162-186. doi:10.1598/RRQ.39.2.2

Wang, M., & Degol, J. (2013). Motivational pathways to STEM career choices: Using expectancy–value perspective to understand individual and gender differences in STEM fields. *Developmental Review, 33,* 304-340. doi:10.1016/j.dr.2013.08.001

Waschescio, U. (1998). The missing link: Social and cultural aspects in social constructivist theories. In F. Seeger, J. Voigt, U. Waschescio, F. Seeger, J. Voigt, U. Waschescio (Eds.), *The culture of the mathematics classroom* (pp. 221-241). doi:10.1017/CBO9780511720406.009

Watermann, R., & Klieme, E. (2002). Reporting results of large-scale assessment in psychologically and educationally meaningful terms: Construct validation and proficiency scaling in TIMSS. *European Journal of Psychological Assessment, 18*(3), 190-203. doi:10.1027//1015-5759.18.3.190

Watts, T. W., Duncan, G. J., Chen, M., Claessens, A., Davis-Kean, P. E., Duckworth, K., & ... Susperreguy, M. I. (2015). The role of mediators in the development of longitudinal mathematics achievement associations. *Child Development, 86*(6), 1892-1907. doi:10.1111/cdev.12416

Weiner, B. (1985). An attributional theory of achievement motivation and motion. *Psychological Review, 92*(4), 548-573. doi:10.1037/0033-295X.92.4.548

Wigfield, A. (1994). Expectancy-value theory of achievement motivation: A developmental perspective. *Educational Psychology Review, 6*(1), 49-78. doi:10.1007/BF02209024

Wigfield, A. (1997). Reading motivation: A domain-specific approach to motivation. *Educational Psychologist, 32*(2), 59-68. doi:10.1207/s15326985ep3202_1

Wigfield, A., & Cambria, J. (2010). Students' achievement values, goal orientations, and interest: Definitions, development, and relations to achievement outcomes. *Developmental Review, 30*(1), 1-35. doi:10.1016/j.dr.2009.12.001

Wigfield, A., & Eccles, J. S. (2002a). *Development of achievement motivation*. San Diego: Academic Press.

Wigfield, A., & Eccles, J. S. (2002b). The development of competence beliefs, expectancies for success, and achievement values from childhood through adolescence. In A. Wigfield, & J. S. Eccles (Eds.), *Development of achievement motivation* (pp. 91-120). San Diego, CA, US: Academic Press. doi:10.1016/B978-012750053-9/50006-1

Wigfield, A., Eccles, J. S., Fredricks, J. A., Simpkins, S., Roeser, R. W., & Schiefele, U. (2015). Development of achievement motivation and engagement. In M. E. Lamb, R. M. Lerner, M. E. Lamb, & R. M. Lerner (Eds.), *Handbook of child psychology and developmental science: Socioemotional processes,* (7 ed., Vol. 3, pp. 657-700). Hoboken, NJ: John Wiley & Sons Inc.

Wigfield, A., Tonks, S., & Klauda, S. L. (2009). Expectancy-Value theory. In K. R. Wenzel, & A. Wigfield (Eds.), *Handbook of motivation at school* (pp. 55-75). New York, NY: Routledge/Taylor & Francis Group.

Xu, M. K., Marsh, H. W., Hau, K., Ho, I. T., Morin, A. S., & Abduljabbar, A. S. (2013). The internal/external frame of reference of academic self-concept: Extension to a foreign language and the role of language of instruction. *Journal of Educational Psychology, 105*(2), 489-503. doi:10.1037/a0031333

Yu, A., & Yang, K. (1994). The nature of achievement motivation in collectivist societies. In U. Kim, H. C. Triandis, Ç. Kâğitçibaşi, S. Choi, G. Yoon, U. Kim, ... G. Yoon (Eds.), *Individualism and collectivism: Theory, method, and applications* (pp. 239-266). Thousand Oaks, CA: Sage Publications, Inc.

Yu, C. H. (2012). Examining the relationships among academic self-concept, instrumental motivation, and TIMSS 2007 science scores: a cross-cultural comparison of five East Asian countries/regions and the United States. *Educational Research & Evaluation*, *18*(8), 713-731. doi:10.1080/13803611.2012.718511

Zhu, Y. y., & Leung, F. (2011). Motivation and achievement: Is there an East Asian model? *International Journal of Science & Mathematics Education, 9*(5), 1189-1212. Retrieved from http://springerlink.com

Zimmerman, B. J. (1989). A social cognitive view of self-regulated academic learning. *Journal of Educational Psychology*, *81*(3), 329-339. doi:10.1037/0022-0663.81.3.329

## Appendix

Table 13. *Correlation Among the Variables*

| 1 | Variables | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| | Self-Concept | | | | | |
| 2 | Intrinsic Value | .710** | | | | |
| 3 | Utility Value | .410** | .540** | | | |
| 4 | Science Achievement | .255** | .209** | .150** | | |
| 5 | Peer Math Achievement | .012* | .091** | -.080** | .550** | |
| 6 | Math Achievement | .361** | .328** | .126** | .845** | .682** |
| | Mean | 22.71 | 26.76 | 556.82 | 577.35 | 577.44 |
| | Std. Deviation | 7.377 | 5.939 | 83.422 | 62.881 | 91.991 |

Note. N = 35385
* Significant at the 0.05 level, ** significant at the 0.01 level