Research Report

Self-Constructs and Anxiety Across Cultures

Jihyun Lee

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Jihyun Lee
ETS, Princeton, New Jersey

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Abstract

This study examined the factorial structure of three related constructs, math self-concept, math self-efficacy, and math anxiety, across 41 countries. One factorial structure was achieved at both between- and within-country levels. Within-country variations of the self-constructs were also noted in relation to math performance: Self-concept showed the strongest correlations in some Western European countries, but it was self-efficacy that demonstrated the strongest correlations among Asian and Eastern European countries. Findings also indicate that students in some Asian countries have low math self-concept and math self-efficacy and high math anxiety despite high math performance, while students in some Western European countries have high math performance and low levels of math anxiety.

Key words: Math performance, PISA, self constructs, factorial structure

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Researchers in many subdomains of psychology have investigated the thoughts and feelings that people have about themselves (Marsh & Hau, 2004; Scholz, Dona, Sud, & Schwarzer, 2002).According to Bandura's social-cognitive theory (Bandura, 1977, 1997), how people think and feel about themselves impacts their actions, especially when they face challenging circumstances. Various psychological terms have been coined to describe different aspects of the self such as *self-concept* (e.g., Marsh & Hau, 2004; Marsh, Smith, & Barnes, 1985; Marsh & Yeung, 1997; Martin & Marsh, 2008) and *self-efficacy* (e.g., Bandura, 1977; Midgley, Feldlauger, & Eccles, 1989; Pajares, 1996; Pajares & Kranzler, 1995; Pajares & Miller, 1994). In terms of educational achievement and motivation, these two terms have probably been given most attention. Bong and Clark (1999) defined *self-concept* as the perception of the self that is continually evaluated and reinforced by personal inferences. Bandura (1997) defined *self-efficacy* as one's conviction or belief about one's own capability to produce desired outcomes. *Anxiety*, another self-related construct, has been defined as one's physio-emotional reactions when one thinks about or performs a particular task (Ashcraft, 2002; Hembree, 1990; Pintrich & DeGroot, 1990; Sarason & Sarason, 1990; Spielberger, 1985), and it is often provoked when the task is given by external systems such as schools or exams.

Much of the research into self-concept has been conducted by Marsh and his colleagues (Marsh, Byrne, & Shavelson, 1988; Marsh & Hau, 2004; Marsh, Hau, & Kong, 2002; Marsh, Koller, & Baumert, 2001; Marsh, Smith & Barnes, 1985; Marsh & Yeung, 1998; Martin & Marsh, 2008). Pajares and his colleagues (e.g., Pajares & Graham, 1999; Pajares & Kranzler, 1995; Pajares & Miller, 1994; Pajares & Miller, 1997; Pajares & Urdan, 1996) were instrumental in developing conceptual models for self-efficiency research. Studies of the relative predictive power of self-concept and self-efficacy in regards to academic performance have also been conducted (see Marsh, Walker, & Debus, 1991; Pajares & Miller, 1994), but no real consensus has been reached.

Studies on whether self-concept, self-efficacy, and anxiety can be distinguished empirically from each other is notably missing from the literature. While there have been studies that show detailed theoretical differentiations between self-concept and self-efficacy (c.f., Bandura, 1986; Bong & Clark, 1999; Bong & Skaalvik, 2003; Pajares, 1996,), operational definitions of the various self-constructs have not been clearly distinguished in many studies (Bong & Clark, 1999; Pajares & Miller, 1994). One study, for example, that found academic self-concept predicted college grades better than self-efficacy (Choi, 2005), used items that were virtually indistinguishable to measure the two constructs. Another study that found self-efficacy had a direct effect on mathematics performance and self-concept did not (Pietsch, Walker, & Chapman, 2003) had an extremely high correlation (r = .93) between putative self-concept and self-efficacy measures (see Marsh, Dowson, Pietsch, & Walker, 2004). According to Bong (1996), this lack of a operational definition of self-constructs may be due to the fact that "indicators of [different self-constructs] shares a common underlying factor that is not directly observable" (p. 156).

Distinguishing Self-Constructs

Speculations have been made about why researchers may fail to precisely operationalize different self-constructs in their studies. One possible explanation coming from the theoretical point of view suggests the possibility of overlapping subdimensions that may be shared by different self-constructs. That is, both self-concept and self-efficacy involve the cognitive dimension of self-evaluation as these two self-constructs are formulated based on one's judgment of either oneself as a person (i.e., self-concept) or one's capability to perform a particular task (i.e., self-efficacy; Parajes, 1996). Meanwhile, the affective dimension of self-appraisal would influence both self-concept and anxiety in that one's affective responses to self-worth would contribute to one's self-concept (Bong & Clark, 1999; Pajares & Miller, 1994) and that anxiety is generated by affective responses such as tension, worries, and fear (Ghee & Khoury, 2008). Furthermore, Bandura's social-cognitive theory (1986, 1997) suggested that negative physio-emotional states including anxiety, depression, and helplessness are associated with (lower) levels of one's self-efficacy (Scholz et al., 2002). In fact, the question has been raised as to whether cognitive and affective components of self-concept can be empirically distinguishable and how subcomponents of self-concept may be related to other self-constructs such as self-efficacy or anxiety, but no investigation has been carried out to date (Bong & Skaalvik, 2003).

Several empirical studies have also raised the question of whether various self-constructs are distinguishable especially when they are assessed within one domain (e.g., mathematics). The question was whether construct distinction existed among math self-concept, math self-efficacy, and math anxiety when they were employed to predict math performance (see Pajares & Graham, 1999; Pajares & Kranzler, 1995; Pajares & Urdan, 1996). Several studies have reported sizable correlations (ranging from .30 to .70) among these self-constructs: math self-concept and math-self-efficacy (Pajares & Kranzler, 1995; Pajares & Urdan, 1996), math anxiety and math self-concept (e.g., Pajares & Kranzler, 1995; Pajares & Miller, 1994), and math anxiety and math self-efficacy (e.g., Betz & Hackett, 1983; Hackett, 1985; Lent, Lopez, & Bieschke, 1991). Furthermore, high predictive power among math self-concept, math self-efficacy, and math anxiety has been documented (Pajares & Kranzler, 1995; Pajares & Urdan, 1996) regardless of the implied causal direction in the predictability of one self-construct over the other. For instance, math self-concept was a significant predictor of math self-efficacy (e.g., Randhawa, Beamer, & Lundberg, 1993) as well as a significant predictor of math anxiety (e.g., Hackett & Betz, 1989). Math self-efficacy was a significant predictor of both math self-concept (e.g., Parajes & Miller, 1994) and math anxiety (e.g., Hackett, 1985; Hackett & Betz, 1989; Parajes & Miller, 1994).

In sum, previous research has indicated that different self-constructs, especially when they are assessed in the context of one domain (e.g., mathematics), may not be empirically distinguishable from each other. The present study searches for empirical evidence of construct separation among math self-concept, math self-efficacy, and math anxiety. This question is set up partly to respond to the concern raised by Parajes and his colleagues (Pajares & Miller, 1994; Pajares & Kranzler, 1995; Pajares & Urdan, 1996), who illustrated that math self-concept and math anxiety may be too closely related (Pajares & Miller, 1994; Pajares & Kranzler, 1995) and pointed out that the conceptual and empirical distinction between math self-concept and math self-efficacy is not always clear (Pajares & Kranzler, 1995). The question then becomes whether these three closely related self-constructs (math self-concept, math self-efficacy, and math anxiety) are indeed independent psychological constructs that can be empirically separable from each other. A positive answer is typically assumed, and no formal studies have illustrated this point.

The present study employs a rigorous way to validate the constructs' existence, which is testing through culturally diverse settings. A cross-cultural context is an ultimate setting to test, explore, and integrate—existing and new—universal psychological constructs (Segall, Lonner, & Berry, 1998); to determine replicability and generalizability of the findings (Marsh, Hau, Artelt, Baumert, & Peschar, 2006; van de Vijver & Leung, 2000); to establish the basis for external validity of constructs, theories, or models (Marsh et al., 2006); and to provide both theoretical and practical information on how particular constructs, theories, or models should be interpreted in different cultural settings (Klassen, 2004).

Self-Constructs Research in a Cross-Cultural Context

Self-Concept

Much of cross-cultural self-concept research employs indirect methods to show universal existence of self-concept as a construct. Typically research is done either by demonstrating similar psychometric properties of an instrument measuring self-concept across different cultures (e.g., Marsh et al., 2002) or by showing similar relationships with other measures (e.g., achievement) across different countries (e.g., Nishikawa, Norlander, Fransson, & Sundbom, 2007). For instance, the Self-Description Questionnaire II (SDQII; Marsh, 1992) has been adopted in many different languages (e.g., Chinese, German, French, Japanese, and Swedish), and several studies demonstrated that this instrument had sufficient psychometric properties across different cultures (Marsh et al., 2002; Marsh et al., 2001; Nishikawa et al., 2007; Yeung & Lee, 1999). A recent study by Marsh and Hau (2004) suggested generalizability of a similar pattern of relationships between the verbal and math self-concept and the corresponding measures of achievement across 26 countries using the data from the Programme for International Student Assessment (PISA) sample collected in 2000. Meanwhile, a few studies have employed a more direct approach via factor analyses, attempting to show the existence of academic self-concept as a distinctive factor across cultures. For instance, academic self-concept was found to be a robust, separate factor in the samples of France and Italy (Corbiere, Fraccaroli, Mbekou, & Perron, 2006); Australia and Canada (Marsh & Byrne, 1993); Korea and the United States (Chong & Michael, 2000); and Korea, Japan, and the United States (Henderson, Marx, & Kim, 1999).

Studies reporting different levels of self-concept across countries have demonstrated a general trend of lower values of Asian countries when compared to the rest of the world (i.e., American, African, European, Middle Eastern, and Australasian). For instance, Wilkins (2004) reported that Hong Kong, Japan, and Korea showed the lowest math self-concept across 24 countries. In the same study, the lowest science self-concept is found in these three Asian countries, followed by Singapore and Thailand. In addition, this pattern of low self-concept among Asian students appears on both academic and nonacademic self-concept (Nishikawa et al., 2007). Meanwhile, most cross-cultural studies, with a few exceptions (e.g., Marsh & Hau, 2004; Marsh et al., 2006; Wilkins, 2004), are conducted based on a few countries, and thus studies that provide a global picture of self-concept are still very rare. Furthermore, a paucity of cross-cultural studies exists on more specific types of self-concept, such as mathematics self-concept.

Self-Efficacy

Cross-cultural self-efficacy research has linked self-efficacy concept to the theory of the self in individualistic (i.e., independent self) and collectivistic (i.e., interdependent self) cultures (Hofstede, 1980; Klassen, 2004; Markus & Kitayama, 1991; Triandis, 1999). In Western individualistic cultures, achieving personal goals and one's past performance are driving forces in the formulation of the self, whereas in Eastern collectivistic cultures the sense of belongings and social persuasion are used as focal references in shaping the self-perception (c.f., Markus & Kitayama, 1991; Triandis, 1999). Thus, this notion of culturally diverse sources of self-formulation supports the argument that self-efficacy beliefs may have fundamentally different meanings across different cultures (Earley, Gibson, & Chen, 1999; Klassen, 2004; Schaubroeck, Lam, & Xie, 2000). That is, since individual achievement through personal control is at the core of self-efficacy concept, self-efficacy would be well seated within the minds of the individuals in Western cultures but may not be in Eastern cultures (Klassen, 2004). Furthermore, researchers believe that different construals of self would result in different levels of self-efficacy with lower levels of self-efficacy typically expected in Eastern collectivistic cultures and higher levels of self-efficacy generally found in Western individualistic cultures (Klassen, 2004). This argument has been supported in Scholz et al. (2002) where Hong Kong, Japan, and Korea (along with Poland) showed the lowest values on the general self-efficacy scale across 25 countries.

On the other hand, Bandura (2002) emphasized universal existence and utilities of self-efficacy in attaining individual achievement. He suggested that self-efficacy must function in a similar fashion across diverse cultures because it plays a significant role in facilitating desirable behaviors and overcoming adversities and thus helps individuals of any culture to achieve their personal goals. A study by Scholz et al. (2002) supported Bandura's argument by showing the existence of one single factor of general self-efficacy across 25 countries including Western and Eastern European, East and Southeast Asia, North and South American, and Middle Eastern countries. Meanwhile, cross-cultural studies on specific types of self-efficacy such as math self-efficacy (which is the focus of this paper) have not been conducted with a broad spectrum of countries. The present study aims to provide a global picture on levels of math self-efficacy across 41 countries.

Anxiety

The existence of anxiety as a basic human emotion has been recognized across cultural boundaries (Bodas & Ollendick, 2005; Engelhard, 2001). Anxiety in relation to achievement-motivation has been studied within a specific domain or task, such as test anxiety (e.g., Hembree, 1988; Bodas & Ollendick, 2005) or math anxiety (e.g., Engelhard, 2001). Some researchers view math anxiety as a subject-specific form of test anxiety (Bandalos, Yates, & Thorndike-Christ, 1995; Hembree, 1990). Test anxiety has been explored in many different cultures ranging from Far East to Middle East, Africa, Western and Eastern Europe, and North America with the general conclusion that test anxiety is a common phenomenon across cultures (Bodas & Ollendick, 2005). However, cross-cultural studies on math anxiety are surprisingly rare, and little is known about generalizability of math anxiety as a psychological construct across different cultures (Ho et al., 2002).

Relationships to Math Performance

Studies that employed cross-cultural data have documented small to moderate sizes of correlations in the relationship between math performance and math self-concept, math self-efficacy, and math anxiety. Marsh et al. (2006), based on 25 countries, demonstrated the cross-cultural invariant correlations to be as follows: 0.30 between verbal self-concept and reading achievement, 0.33 between math self-concept and math achievement, 0.27 between academic self-efficacy and reading achievement, and 0.29 between academic self-efficacy and math achievement. In a meta-analysis by Ma (1999), a similar size (negative) of -0.27 is reported as the population correlation on the relationship between math performance and math anxiety. This meta-analysis is based on the studies carried out with school students (grades 4 through 12) in Australia, America, Israel, Lebanon, New Zealand, and Thailand. Another meta-analysis (Hembree, 1990) on anxiety shows slightly stronger correlations of -0.34 for students in grades 5 through 12 and -0.31 for college students.

Although these studies provide some guidance to what can be expected in the relationship of math performance to math self-concept, math self-efficacy, and math anxiety, more detailed cross-cultural information, such as a relative strength of these relationships in different cultures, is missing from the literature. Several studies have examined this topic (e.g., American versus Taiwanese in Chen & Zimmerman, 2007; American versus Thai in Engelhard, 2001; American, Chinese, and Taiwanese in Ho et al., 2002; Arab and Israeli in Nasser & Birenbaum, 2005), but consistent cross-cultural results have not been achieved. Furthermore, most of these studies compare only two or three country groups, making it hard to claim a generalization about a pattern of relationships that may arise in diverse cultures.

Summary

A majority of studies on self-concept, self-efficacy, or anxiety has responded to questions on whether particular cultures/countries would have higher or lower country means on certain self-constructs (e.g., Eaton & Dembo, 1997; Klassen, 2004; Nasser & Birenbaum, 2005; Randhawa & Gupta, 2000). However, there is no accumulated empirical evidence for whether closely related self-constructs are universally applicable across different cultures (Artelt, 2005). Furthermore, specific self-constructs in a particular domain (e.g., mathematics) have hardly been examined cross-culturally although interest has increased regarding how these self-constructs might be influenced by cross-cultural settings (Bodas & Ollendick, 2005; Klassen, 2004; Marsh et al., 2002). The focus of the present paper is not so much to document the country-level mean differences but to investigate whether different but closely related self-constructs (math self-concept, math self-efficacy, and math anxiety) can be observed as an independent constructs and furthermore, if so, to determine whether the construct independence among these three self-constructs can be sustained across diverse cultural groups.

Study Goals

The present study aims to examine whether closely related self-constructs assessed in a context of one domain—math self-concept, math self-efficacy, and math anxiety—can be differentiated from each other. Pajares and Kranzler (1995) stated that “the conceptual interrelatedness between self-concept and self-efficacy judgments is such that separating them empirically is a research enterprise of its own” (p. 429), but no formal studies have explored this topic. A rigorous way to demonstrate construct existence is through cross-cultural validation (Marsh et al., 2006; Segall et al., 1998; van de Vijver & Leung, 2000). Cross-cultural studies on self-constructs so far have typically been carried out with a single self-construct and often based on the responses from English-speaking Western countries—the United States, Australia, and

Canada (Marsh et al., 2002; Marsh & Hau, 2004). The present study is based on individuals from 41 countries who participated in the PISA 2003 project. The present study was conducted with the expectation that a clear-cut construct separation among math self-concept, math self-efficacy, and math anxiety may not be obtainable due to the conceptual interrelatedness, especially when examined across a fairly large number of countries (i.e., 41 countries). On the other hand, if the results of this study show the evidence for the construct separation among math self-concept, math self-efficacy, and math anxiety, a reasonably strong empirical support of their universal existence will be provided. Thus, the research questions in this study are (a) whether math self-concept, math self-efficacy, and math anxiety are constructs distinguishable from each other; and (b) whether one consistent factor structure (i.e., a three-factor model with each factor representing each of the self-constructs—math self-concept, math self-efficacy, and math anxiety) can exist across different cultures. In addition, as further validation evidence for the three constructs, the relationship to the math performance of each of the three self-constructs is explored with between- and within-countries analyses. If different patterns of the relationships are found between each of the math self-constructs and the math performance across countries, the patterns can be viewed as indirect evidence for the existence of each of the three constructs. The overarching goal of the present study is to provide an empirical basis for the universal existence of the closely related self-constructs that are related to mathematics.

Method

Participants

The present study employs the student questionnaire data of the PISA 2003 project. The PISA 2003 project, conducted by the Organization for Economic Co-operation and Development (OECD), released the public-use data on both cognitive test results (mathematics as a major cognitive subject in 2003, reading, science, and problem solving) and responses on the PISA 2003 background questionnaires for students and for schools. The participant students are 15-year-olds in 41 countries who attended school at the time of PISA 2003 administration (the countries are listed in Table A2). The total number of participants (i.e., the sample size for this study) was more than 250,000, which represented about 23 million 15-year-olds attending schools in the 41 countries (Organisation for Economic Co-operation and Development [OECD], 2004). The country sample sizes varied, ranging from 3,350 in Iceland to 30,000 in Mexico. For more information about the project framework, refer to OECD (2004, 2005).

Measures

Math self-concept. The PISA 2003 participant students responded to five math self-concept items that were presented with a 4-point Likert-type response of *strongly agree, agree, disagree*, and *strongly disagree*. The actual items are as follows: "I have always believed that mathematics is one of my best subjects," "I learn mathematics quickly," "In my mathematics class, I understand even the most difficult work," "I get good grades in mathematics," and "I am just not good at mathematics."

Math self-efficacy. Six items were used to assess the level of math self-efficacy. The item stem of "How confident do you feel about having to do the following mathematics tasks?" was followed by six specific types of math activities: calculating the number of square feet of tile needed to cover a floor, calculating how much cheaper a TV would be after a 30% discount, using a train timetable to work out how long it would take to get from one place to another, understanding graphs presented in newspapers, finding the actual distance between two places on a map with a 1:100 scale, and calculating the gas mileage of a car. A 4-point Likert-type response of *very confident, confident, not very confident*, and *not at all confident* was given to the respondents.

Math anxiety. Five math anxiety items were employed with a 4-point scale of agree-disagree responses: "I get very nervous doing mathematics problems," "I get very tense when I have to do mathematics homework," "I often worry that it will be difficult for me in mathematics classes," "I feel helpless when doing a mathematics problem," and "I worry that I will get poor grades in mathematics."

In the original data file, more positive responses on these three variables were assigned with lower values (e.g., *strongly agree* is assigned with "1"), but the order of values were recoded in the analysis of this study so that higher values mean "more" of the particular construct.

Analysis

A series of factor analyses was carried out: (a) exploratory factor analysis (EFA) with all countries combined, (b) EFA for each of 41 countries separately, (c) confirmatory factor analysis (CFA) with all countries combined, and (d) multiple-group CFA. The Mplus program version 4.2 (Muthen & Muthen, 2006) was used for all steps of the factor analyses described. The rates of missing data on all 16 self-construct items were low in the original public-use data file—less than 2% from the total responses at the item level—and thus the missing values were treated as missing at random for the analysis of this study. The EFA was conducted to capture an overall structure existing across all 16 items employed in this study. The correlation matrix was entered as input and the maximum likelihood method was used for factor extraction. The promax rotation was used, allowing the emerging factors to be correlated. The result from EFA was used as the basis for CFA.

As recommended by Jöreskog and Sörbom (1993) and Marsh et al. (2006), the covariance matrix was entered as input for CFA and multiple-group CFA in which variables from different groups were placed into one common scale. In all CFA modeling, factor loadings and factor intercorrelations were left free to be estimated, and error terms were uncorrelated. Several model fit indexes of CFA models were employed, including the minimum fit function χ^2, the comparative fit index (CFI; Bentler, 1990), the Tucker-Lewis index (TLI; Tucker & Lewis, 1973), and the root mean square error of approximation (RMSEA; Steiger, 1988, 1990). The conventional threshold values for a good model fit were numbers greater than .90 for CFI and .95 for TLI. For RMSEA, values smaller than .05 were considered ideal and smaller than .08 were acceptable (for a detailed description of these thresholds, refer to Bollen and Long, 1993, and for a description of how these indexes can be used, refer to Newman, Bolin, and Briggs, 2000). With multiple-group CFA, a series of nested models were tested to explore the measurement and population invariance across countries. Testing of the configural invariance in a CFA model was used to examine whether one equivalent factor structure was applicable to the data for different countries. Subsequently, model restriction of invariance for factor loading, factor residuals, factor correlations, factor variances, and factor means were imposed on each sequential CFA model. In terms of evaluating CFA models, typical practice (especially dealing with behavioral data) was to examine fit indexes described here rather than to focus on tests for statistical significance of the chi-square statistics (Marsh, Hau, & Grayson, 2005; Marsh et al., 2006). When evaluating nested models with increasing levels of invariance constraints, the relative fit between nested models should take greater importance than the absolute fit of a model (Marsh et al., 2006). For example, decreases in fit indexes greater than .01 could be considered important changes (Cheung & Rensvold, 2002). Furthermore, some degree of subjectivity was often called upon when making the decision on appropriateness of a model (Marsh et al., 2006).

Results

Exploratory Factor Analysis (EFA)

Exploratory factor analysis was carried out panculturally, meaning each data point was treated without taking into account the country of origin. Using three criteria for determination on the number of factors—the Kaiser-Guttman eigenvalue greater-than-1-criterion (Kaiser, 1960), the scree plot (Cattell, 1966), and the parallel analysis (Horn, 1965)—three interpretable factors emerged: math self-concept, math self-efficacy, and math anxiety (see Table A1 in the appendix). All items showed moderately strong factor loadings (all greater than .43), all but one item showed a single loading on a factor, and a fair amount of total variance in the items (58%) was explained by these three factors. The factor correlations were moderate in size (from -.45 to -.67), which fell under an expected range from previous studies (e.g., Pajares & Graham, 1999; Pajares & Kranzler, 1995; Pajares & Urdan, 1996).

The EFA was also performed with 41 countries separately. Using the eigenvalue greater than 1 as a criterion of factor extraction, 33 countries out of 41 produced a three-factor solution (see Table A2). Only eight countries were the exception: two South American countries (Brazil and Mexico) showing a two-factor solution and six countries showing a four-factor solution (Canada, Denmark, Greece, Ireland, Macau-China, and United States). Although there were some variabilities in the variance explained by the three factors across countries, the three factors explained the variance of the 16 self-construct items relatively well, ranging from 47% (Indonesia) to 66% (Iceland).

Confirmatory Factor Analysis (CFA)

The three-factor structure shown in the EFAs from both the pancultural and country-specific analyses was used for the factor structure of the following CFAs. One item ("I am just not good at mathematics"), which had loadings on two factors (math self-concept and math anxiety) in the EFA, was specified to load on the math anxiety scale only. Five CFA models were tested, from the one without any model constraint progressing to the models with more restricted model conditions. Model 1 is a pancultural, no-constraint CFA model, which is an examination of the CFA model fit based on the EFA result. Models 2 through 5 are the multiple-group CFAs where model restrictions are nested, meaning that a new restriction is introduced to the next model in addition to the existing restrictions of the previous models. The measurement invariance was tested first in Models 2 and 3 and then the test on the population heterogeneity invariance was performed in Models 4 and 5. The restriction imposed on Model 2 was that the same items were loaded on the same factors and the number of factors was held invariant across all 41 countries (i.e., configural invariance). Model 3 had two additional restrictions where the factor loadings and residual variances were constrained to be invariant across all countries. At this stage (Model 3), the model constraints were quite restricted since it would have been hard to observe invariant factor loadings and invariant residual variances across as many as 41 countries. In Model 4, factor correlations across 41 countries were constrained to be equal. Again, arriving at one factor model with the additional constraint of invariant factor correlations across 41 countries would have been hard to achieve. An additional constraint of invariant factor variances was applied across all countries in Model 5 where constraints of invariant factor loadings, invariant residual variances, invariant factor correlations, and invariant factor variances were all applied to the data of 41 countries simultaneously. At the final stage of model specification, a very strict set of the invariance conditions was applied to the multiple-group CFA.

Results on the model fits described here are summarized in Table A3. First of all, the model fits between the consequent models (e.g., Model 1 versus Model 2; Model 2 versus Model 3) are statistically different ($p < .001$) based on the χ^2 differences. However, the χ^2 test is heavily influenced by sample sizes, and thus a more appropriate way to evaluate models is examination of the other indexes shown in Table A3, such as CFI, TLI, and RMSEA (Marsh et al., 2005; Marsh et al., 2006). Model 1, where the number of factors is fixed at 3 in the data across all 41 countries, shows a satisfactory model fit. All fit indexes fall within the criterion of a good model fit, with CFI of .95, TLI of .94, RMSEA of .06. In Model 2, where configural invariance is imposed (meaning that the same set of items is loaded on the same factors across 41 countries), the fit indexes indicate a reasonably good fit given that both CFI and TLI are .92 and RMSEA is .07. This model indicates that it is reasonable to think that an equivalent three-factor structure is applicable across all 41 countries. Model 3 shows some degree of deterioration on the fit with decreasing values of .03 in CFI and .02 in TLI compared to the fit of Model 2. This decrease in the model fit is expected since the invariant factor structure with the invariant factor loadings and invariant residual variances across 41 countries is hard to achieve. In fact, given this strict condition, Model 3 shows a reasonable fit, which is supported by .07 RMSEA. Additionally, when the fits of the Models 4 and 5 are examined, there is only a maximum of a .01 difference in CFI, TLI, and RMSEA by adding a condition of invariant factor correlations and invariant factor variances. Given all the constraints imposed on the final model (Model 5) and the number of groups modeled simultaneously, the final model with RMSEA of .08 should be considered as showing a reasonable model fit.

In conclusion, the EFA and CFA results described here seem to indicate that the three factors appear to exist across 41 countries. Furthermore, a reasonable fit is obtained with a very restricted set of model conditions imposed in Models 3, 4, and 5.

Country-Level Factor Means

Country-level factor score means for each of the three factors were calculated with the means on each factor for the entire sample set to be 0. Table A4 provides a summary of the country factor means where the countries showing the highest 10 and lowest 10 factor means are listed. On the scale of math self-concept, the United States is placed on top, while four Confucian countries (Japan, Korea, Hong Kong, and Macau-China) show the lowest scores (see Table A4). Again, three Asian countries (Japan, Korea, and Thailand) show the lowest scores on the math self-efficacy scale, while the United States and European (both Western and Eastern) countries such as Liechtenstein, Slovakia, and Switzerland show the highest scores on the same scale. Among the 10 highest math anxiety countries, the six countries are either from Asia (i.e., Thailand, Japan, Indonesia, and Korea) or South America (Brazil and Mexico). The presence of Western European countries such as Sweden, Denmark, and Finland dominates the lower end of the math anxiety scale.

All 41 countries are placed on the scale of math self-concept (Figure 1), math self-efficacy (Figure A2), and math anxiety (Figure A3) based on the country-means of each of the factors. Table A5 shows the country-mean for the PISA 2003 mathematics scores of all participating countries. The darker shaded bars are used in the figures to indicate the countries with above average PISA 2003 mathematics scores; the horizontal line represents the mean of 0 on the factor scores. Figure 1 shows that most of the above average math performing countries are placed below average on the math self-concept scale. Generally speaking, this indicates that countries that performed well on the PISA math test show low levels of the math self-concept, although some countries (Canada, Australia, New Zealand and some Western European countries) demonstrate the optimal outcomes (high on both test scores and self-concept). On the other hand, most countries that performed above average also show higher levels of math self-efficacy (see Figure 2). Only three exceptions were found: Finland, Japan, and Korea scored high on the math test but showed low confidence on the math self-efficacy scale. When it comes to the math anxiety, the above average math performing countries tend to show low levels of anxiety, which includes countries from Western Europe and New Zealand, Hong Kong, and Macau-China. However, some countries, such as Australia, Belgium, Canada, Czech Republic, France, Ireland, Japan, and Korea, performed well on the math test but exhibited high math anxiety (see Figure A3).

The overall relationships of the math scores to each of the three self-constructs at the country level for PISA 2003 can be summarized in the between-country correlations, as follows: math self-concept = -.45, math self-efficacy = .42, and math anxiety = -.65. (Correlations are significant at the 0.01 level [2-tailed].) The between-country correlations reveal two surprising results: (a) math anxiety (r = -.645; $p < .001$) shows a stronger correlation with the math scores than those of math self-concept (r = -.447; $p < .001$) and math self-efficacy (r = .419; $p < .001$); and (b) a positive relationship is found between math self-efficacy and the math scores, but a negative relationship is shown between math self-concept and the math scores.

Further Evidence of Validity: Correlations with Academic Performance

Correlations between each of the three factors and the PISA math test scores are calculated within each country, as shown in Table A6. The countries with the 10 highest and the 10 lowest correlations, are labeled as high and low groups, respectively, in this table.. In deciding high or low correlations calculated based on large-scale data such as that employed in this study, examining by the rank order in absolute values of the correlations is more appropriate than focusing on the actual correlation values or on the statistical significance of the correlations. In fact, all correlations presented in Table A6 are statistically significant ($p < .01$), which is at least partly influenced by the large numbers of participants within countries. As can be seen in Table A6, the countries with the highest correlations of the math scores with math self-concept are from Western Europe, such as Finland, Norway, Denmark, Iceland, and Sweden. On the other hand, the highest correlations with math self-efficacy are found mostly in Eastern European and Asian countries such as Slovakia, the Czech Republic, Hong Kong, Japan, Korea, Hungary, and Poland. Meanwhile, the highest correlations between the math scores and math anxiety are found mostly in the Western and Eastern European countries such as Denmark, Norway, Poland, and Finland. Asian countries, such as Hong Kong, Japan, Korea, Macau-China, Thailand, and Indonesia, along with the Netherlands, Belgium, and France, are among the countries showing the lowest correlations with math anxiety. Thailand and Indonesia were among the countries with the lowest correlations between all three self-constructs and the mathematics score.

Another key observation to be made in Table A6 is whether the countries would show similar relationships to the math scores and each of the self-constructs (e.g., the countries showing a high correlation between the math score and self-concept would also have a high correlation with self-efficacy). If the same group of countries is shown in the high or low correlation category in all three self-constructs columns, construct separability among three self-constructs can be in question. Table A6 shows that for most countries, the relationships of the math scores with one self-construct to another self-construct vary within a country (i.e., a country demonstrating a strong relationship with one self-construct but not with another self-construct). For instance, Finland shows the highest correlation in the math self-concept and the math scores but falls within the middle group when it comes to the correlation with math self-efficacy and the math scores. Greece is among the countries with a high correlation with math self-concept but not with math self-efficacy nor with math anxiety. Hungary is one of the countries showing a high correlation in math self-efficacy but not with math self-concept nor with math anxiety. In general, the countries show different relationships of the math scores with math self-concept, math self-efficacy, and math anxiety. Thailand and Indonesia are the exceptions in that they are grouped into the low correlation category in relation to all three constructs.

Conclusions and Discussion

The goals of the present study was first to examine whether three constructs about self in regards to math performance, math self-concept, math self-efficacy, and math anxiety, could be distinguishable from each other, and then to determine whether there was a consistent factor structure across the 41 countries in this study. Previous research raised the question of whether these three self-constructs are so closely related conceptually that the empirical separation between these three self-constructs is not obtainable (see Pajares & Kranzler, 1995; Pajares & Miller, 1994; Pajares & Urdan, 1996). But this study found that that math self-concept, math self-efficacy, and math anxiety are separate constructs and can be distinguished empirically from each other. This finding is supported across and within countries. In the within-country analysis, 33 countries out of 41 show a three-factor solution underlying a mix of items measuring math self-concept, math self-efficacy, and math anxiety. Sizable variances in the items are explained by these three factors across countries (58%) and within countries (ranging from 47% to 66%). Furthermore, this notion of the three-factor structure for all 41 countries is supported in the findings from a series of CFAs with multiple conditions of model constraints. The model where the same sets of items are loaded on the same factors across 41 countries is well supported using the conventional fit indexes. Furthermore, the fit of the final model reached an acceptable range where a very restricted set of model constraints (i.e., equal factor loadings, equal residual variances, equal factor correlation, and equal factor variances) is imposed across 41 countries. Overall, the universality of the existence of the closely related self-constructs (math self-concept, math self-efficacy, and math anxiety) is supported in this study, although the present study also indicates that the three self-constructs are closely related to each other as demonstrated in previous studies (Pajares & Kranzler, 1995; Pajares & Miller, 1994).

The result of the universality of the self-constructs supported in this study may be related to having extensive pilot studies that preceded the actual data collection of the PISA project. Marsh and his colleagues (2006) have argued that strong support for cross-cultural generalizability can be obtained with “appropriately designed materials, appropriate samples, and carefully standardized administration procedures” (p. 353). The items (adopted from the PISA project and employed in the present study) are clearly written in the sense that each item reflects narrow definitions of the constructs it measures. In particular, the items for measuring math self-concept and math self-efficacy are transparent and distinguishable from each other. Another note to make is that a possible effect from sharing the item stem didn’t seem to play a role in obtaining the structure of the three-factor model. An item stem of “To what extent do you agree…” is shared for math self-concept and math anxiety (the items designed to measure these two constructs are intermixed in order and placed under this item stem). In spite of this item format, these two factors came out as separate factors, which was supported by as many as 41 countries.

The present study also reveals a global view of country-specific information in relation to the constructs of math self-concept, math self-efficacy, and math anxiety. Two dominant phenomena are evident: (a) Asian countries, especially Korea, Japan, and Thailand, demonstrate the low math self-concept and math self-efficacy and high math anxiety and (b) Western European countries such as Austria, Germany, Liechtenstein, Sweden, and Switzerland show high math self-efficacy and low math anxiety. In previous studies (Scholz et al., 2002; Wilkins, 2004), Asian countries showed lowest levels of self-concept and self-efficacy when compared to more than 20 countries. In particular, Wilkins' study concluded that Asian and Eastern European countries showed lower math self-concept than Middle Eastern, Western European, American, and Australasian countries. The conclusion with respect to Asian countries is replicated in the present study in that the three Asian countries—Hong Kong, Japan, and Korea—display the lowest math self-concept among 24 countries in Wilkins' study and among 41 countries in the present study. In addition, Hong Kong, Japan, and Korea demonstrated the lowest self-efficacy levels in the study (Scholz et al., 2002), and it is Japan, Korea, and Thailand that exhibited the lowest math self-efficacy in the present study. Academic-motivational constructs such as math self-concept, math self-efficacy, and math anxiety are inevitably related to the societal and educational environment of countries. In Asian countries, academic achievement is highly valued, parents hold high academic expectations for their children, competitions to do well in school tend to be tense, normative evaluation is commonly taking place, and students have to pass crucial entrance examinations as part of their formal schooling (Ho et al., 2002). Then, understandably, Asian students are accustomed to comparing their abilities to others' and view academic achievement to be high-stake activities. Asian students tend to set high goals and evaluate themselves with strict standards (Whang & Hancock, 1994). Asian students also perceive their parents and themselves to be less satisfied with their school performance compared to non-Asian students (Whang & Hancock, 1994). All of these elements could contribute to high anxiety and low self-concept and self-efficacy of Asian students. On the other hand, in countries where social benefits and value systems are not necessarily built around school achievement, such as in the Western European countries, students tend to be less critical of their academic performance and feel relaxed. Where the United States stands in relation to these three constructs is close to what is seen from the Western European countries: the United States is placed about in the middle range on the math anxiety scale, high on the math self-efficacy scale, and highest on math self-concept.

Several noteworthy findings of this study are found in the examination of the between-country and within-country relationships of math self-concept, math self-efficacy, and math anxiety to the math performance. First, with respect to math self-concept, an overall positive relationship is found at the within-country level, but a negative relationship is present at the between-country level. This finding is consistent with what has been demonstrated in previous studies (e.g., Wilkins, 2004). Second, this pattern found with math self-concept is not repeated with a closely related construct, math self-efficacy, which shows positive relationships to the math performance both at the between- and within-country levels. This finding supports the argument of previous studies (e.g., Marsh, Roche, Pajares, & Miller, 1997; Pajares & Miller, 1994; Pietsch et al., 2003) that math self-efficacy is a better predictor of academic performance than math self-concept is. Third, among the three constructs, the strongest relationship to math performance is found at the between-country level with math anxiety but at the within-country level with math self-efficacy. Fourth, for math self-concept and math anxiety, the relationships to the math performance are stronger at the between-county level than at the within-country level.

The present study also shows the cross-cultural variability in relative strength of the three self-constructs in predicting math performance. Generally speaking, the countries showing the strongest associations between math self-concept and the math performance are found in the Western European regions, whereas it is the countries from Asian and Eastern European regions that demonstrate the strongest associations of math self-efficacy and the math performance. The finding that some Confucian Asian countries (i.e., Hong Kong, Japan, and Korea) display high correlations of self-efficacy with the math performance supports the argument of Bandura (2002) that self-efficacy would not play a lesser role in collectivist cultures just because their cultural values are oriented toward group activities and values. When it comes to math anxiety, the European countries show a stronger association with the math performance, while a weaker association is found within Asian countries.

If the indicators of the desirable outcome of student development are high scores in the tests, high levels of self-concept, high levels of self-efficacy, and low levels of anxiety, then no country appears to have such a combination of perfect outcomes. When considering high-performing countries (i.e., the countries with the 10 highest mean scores), none of these top 10 countries are among the countries with a high level of math self-concept and only two countries out of 10 show high math self-efficacy. However, some of the Western European countries—Finland, Netherlands, Liechtenstein, and Switzerland—come to close to showing balanced outcomes, with high performance on the math test and low levels of math anxiety.

To sum up, the present study found there was construct independence for math self-concept, math self-efficacy, and math anxiety and (generalized this finding to 41 countries. The study also showed there were country-specific aspects of math self-concept, math self-efficacy, and math anxiety and demonstrated a pattern of relationships between these three self-constructs and the math performance across the countries in the study. Each of the self-constructs is essential in explaining the math performance at both between- and within-country levels. Researchers in general believe that higher levels of self-efficacy and self-concept and lower levels of anxiety are related to better self-management through such activities such as setting clear goals, managing time better, better planning, , more self-discipline, and stronger drive and effort (c.f., Bong, & Skaalvik, 2003). All of these activities, individually and collectively, are believed to lead to better cognitive performance.

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Appendix

Table A1

Exploratory Factor Analysis Conducted Panculturally

	Promax rotated factors		
Items	Math self-concept	Math self-efficacy	Math anxiety
I get very nervous doing mathematics problems.			.819
I get very tense when I have to do mathematics homework.			.786
I often worry that it will be difficult for me in mathematics classes.			.626
I feel helpless when doing a mathematics problem.			.561
I worry that I will get poor grades in mathematics.			.534
I have always believed that mathematics is one of my best subjects.	.845		
I learn mathematics quickly.	.771		
In my mathematics class, I understand even the most difficult work.	.751		
I get good grades in mathematics.	.694		
I am just not good at mathematics.	-.443		.430
How confident do you feel about having to do the following mathematics tasks? Calculating how many square feet of tile you need to cover a floor.		.713	
How confident do you feel about having to do the following mathematics tasks? Calculating how much cheaper a TV would be after a 30% discount.		.675	
How confident do you feel about having to do the following mathematics tasks? Using a train timetable to work out how long it would take to get from one place to another.		.610	
How confident do you feel about having to do the following mathematics tasks? Understanding graphs presented in newspapers		.601	
How confident do you feel about having to do the following mathematics tasks? Finding the actual distance between two places on a map with a 1:100 scale.		.592	
How confident do you feel about having to do the following mathematics tasks? Calculating the gas mileage of a car.		.559	
Eigenvalue	1.97	1.23	6.11
Cumulative percentage of variance (prior to rotation)	50%	58%	38%
Rotated factor correlation			
With self-efficacy	.521	--	
With anxiety	-.673	-.450	--

Note. The analysis is based on the combined data from 41 countries (*N* = 276,165).

Table A2

Results of Exploratory Factor Analysis (EFA) Conducted Within Country

Country	*N*	Number of factors	Variance explained
Australia	12,551	3	61.08
Austria	4,597	3	59.78
Belgium	8,796	3	58.23
Brazil	4,452	4	50.90
Canada	27,953	2	64.74
Czech Republic	6,320	3	60.01
Denmark	4,218	2	61.80
Finland	5,796	3	62.76
France	4,300	3	56.31
Germany	4,660	3	62.77
Greece	4,627	2	53.07
Hong Kong	4,478	3	63.71
Hungary	4,765	3	57.18
Iceland	3,350	3	66.33
Indonesia	10,761	3	46.66
Ireland	3,880	2	59.10
Italy	11,639	3	58.02
Japan	4,707	3	62.15
Korea	5,444	3	59.98
Latvia	4,627	3	54.34
Liechtenstein	332	3	60.15
Luxembourg	3,923	3	60.29
Macau-China	1,250	2	61.76
Mexico	29,983	4	49.08
Netherlands	3,992	3	60.19
New Zealand	4,511	3	59.98
Norway	4,064	3	62.53
Poland	4,383	3	59.30
Portugal	4,608	3	57.46
Russian Federation	5,974	3	53.28
Slovakia	7,346	3	57.81
Spain	10,791	3	56.65
Sweden	4,624	3	61.53
Switzerland	8,420	3	59.76
Thailand	5,236	3	53.56
Tunisia	4,721	3	50.96
Turkey	4,855	3	59.21
United Kingdom	9,535	3	60.44
United States	5,456	2	64.10
Uruguay	5,835	3	56.23
Yugoslavia	4,405	3	55.04

Table A3

Results of Confirmatory Factor Analysis (CFA)

Model with specific constraints	χ^2	df	*p* value on Δ χ^2	CFI	TLI	RMSEA
			Pancultural CFA			
1. Pancultural without model constraints	92430	101	--	.95	.94	.06
			Multiple-group CFA			
2. Configural invariance	140509	4661	<.001	.92	.92	.07
3. IFL + IFR	195535	5301	<.001	.89	.90	.07
4. IFL + IFR + IFC	208652	5421	<.001	.89	.90	.08
5. IFL + IFR + IFC + IFV	218431	5541	<.001	.88	.89	.08

Note. Each χ^2 in each model is statistically significant ($p < .001$). The *p* values on the change in χ^2 shown in this table are based on the comparison of Model 1 versus 2; Model 2 versus 3; Model 3 versus 4; and Model 4 versus 5. Although not shown here, the significance tests on all pairs of the χ^2 changes are also performed. All χ^2 changes between any pair of models are statistically significant ($p < .001$). CFI = comparative fit index, TLI = Tucker-Lewis index, RMSEA = root mean square error of approximation, IFL = invariant factor loadings, IFR = invariant factor residuals, IFC = invariant factor correlations, IFV = invariant factor variances.

Table A4

Factor Score Means: Countries With High and Low Pancultural Factors

	Math self-concept		Math self-efficacy		Math anxiety	
High	United States	.254	Liechtenstein	.683	Tunisia	.627
	Tunisia	.235	Slovakia	.410	Thailand	.587
	Denmark	.193	Switzerland	.374	Brazil	.420
	Indonesia	.186	Hungary	.351	Japan	.410
	Canada	.158	Czech Rep.	.285	Mexico	.377
	Mexico	.155	Austria	.280	Indonesia	.364
	Russia	.132	Sweden	.261	Korea	.331
	New Zealand	.103	Germany	.237	Turkey	.313
	Greece	.102	USA	.211	France	.221
	Germany	.087	Hong Kong	.199	Yugoslavia	.192
Low	Latvia	-.182	Mexico	-.127	Uruguay	-0.16
	France	-.223	Russia	-.163	Iceland	-.341
	Spain	-.225	Indonesia	-.222	Germany	-.363
	Norway	-.251	Turkey	-.224	Switzerland	-.368
	Portugal	-.262	Tunisia	-.226	Austria	-.404
	Hungary	-.263	Greece	-.456	Netherland	-.517
	Macau-China	-.270	Brazil	-.519	Liechtenstein	-.552
	Hong Kong	-.305	Korea	-.602	Finland	-.558
	Korea	-.446	Thailand	-.617	Denmark	-.573
	Japan	-.615	Japan	-.917	Sweden	-.687

Table A5

Programme for International Student Assessment (PISA) 2003 Mathematics Country-Mean Scores

Country	Mean (*SE*)
Hong Kong-China	550 (4.5)
Finland	544 (1.9)
Korea	542 (3.2)
Netherlands	538 (3.1)
Liechtenstein	536 (4.1)
Japan	534 (4.0)
Canada	532 (1.8)
Belgium	529 (2.3)
Switzerland	527 (3.4)
Macao-China	527 (2.7)
Australia	524 (2.1)
New Zealand	523 (2.3)
Czech Republic	516 (3.5)
Iceland	515 (1.4)
Denmark	514 (2.7)
France	511 (2.5)
Sweden	509 (2.6)
Austria	506 (3.3)
Germany	503 (3.3)
Ireland	503 (2.4)
OECD average	500 (0.6)
Slovak Republic	498 (3.3)
Norway	495 (2.4)
Luxembourg	493 (1.0)
Hungary	490 (2.8)
Poland	490 (2.5)
OECD total	489 (1.1)
Spain	485 (2.4)
United States	483 (2.9)
Latvia	483 (3.7)
Russian Federation	468 (4.2)
Italy	466 (3.1)
Portugal	466 (3.4)
Greece	445 (3.9)
Serbia	437 (3.8)
Turkey	423 (6.7)
Uruguay	422 (3.3)
Thailand	417 (3.0)
Mexico	385 (3.6)
Indonesia	360 (3.9)
Tunisia	359 (2.5)
Brazil	356 (4.8)

Note. The information in this table is extracted from OECD (2004, page 356).

OECD = Organisation for Economic Co-operation and Development.

Table A6

Within-Country Correlations: Countries With High and Low Correlations With Programme for International Student Assessment (PISA) Mathematics Scores

	Math self-concept		Math self-efficacy		Math anxiety	
High	Finland	.55	Slovakia	.59	Denmark	-.51
	Norway	.54	Czech Rep.	.58	Norway	-.50
	Denmark	.50	Hong Kong	.57	Poland	-.49
	Iceland	.50	Japan	.57	Finland	-.45
	Sweden	.48	Korea	.56	New Zeal	-.45
	Korea	.45	Sweden	.56	Sweden	-.45
	Canada	.43	Hungary	.55	Latvia	-.44
	Poland	.42	Poland	.54	Czech Re	-.44
	Greece	.39	Norway	.54	Slovakia	-.43
	New Zealand	.38	Canada	.51	Canada	-.42
	Slovakia	.38	Denmark	.51	Iceland	-.41
	Australia	.38	Portugal	.51	USA	-.40
	Latvia	.38	Liechtenstein	.51	Russia	-.39
	Portugal	.37	Finland	.51	Ireland	-.38
	Czech Republic	.36	New Zealand	.51	Australia	-.37
	Ireland	.35	United Kingdom	.51	Portugal	-.37
	Spain	.35	Iceland	.50	Greece	-.36
	USA	.35	Australia	.50	Italy	-.35
	Hong Kong	.34	Switzerland	.50	Uruguay	-.35
	United Kingdom	.34	Ireland	.49	Yugoslavia	-.34
	Macau China	.32	Germany	.49	Hungary	-.34
	France	.30	France	.48	Switzerland	-.34
	Italy	.30	USA	.47	Germany	-.34
	Turkey	.30	Austria	.46	Luxembourg	-.33
	Uruguay	.29	Italy	.46	Turkey	-.33
	Russia	.29	Latvia	.45	Austria	-.33
	Austria	.28	Luxembourg	.45	United Kingdom	-.33
	Tunisia	.26	Macau China	.45	Brazil	-.33
	Yugoslavia	.25	Spain	.42	Mexico	-.32
	Switzerland	.25	Turkey	.42	Liechtenstein	-.31
	Liechtenstein	.24	Netherlands	.42	Spain	-.31
Low	Mexico	.23	Russia	.41	Macau-China	-.31
	Germany	.23	Belgium	.38	Hong Kong	-.30
	Hungary	.22	Uruguay	.36	France	-.27
	Luxembourg	.21	Yugoslavia	.34	Belgium	-.27
	Belgium	.19	Greece	.32	Netherlands	-.26
	Netherlands	.19	Tunisia	.32	Korea	-.25
	Brazil	.18	Mexico	.30	Tunisia	-.19
	Japan	.17	Thailand	.28	Japan	-.16
	Thailand	.11	Brazil	.22	Thailand	-.15
	Indonesia	-.05	Indonesia	.15	Indonesia	-.12
Mean		.23		.43		-.39

Note. All the correlations are significant at the 0.01 level (2-tailed). The order in which the countries appear is based on absolute values of the correlations in a three-decimal point.

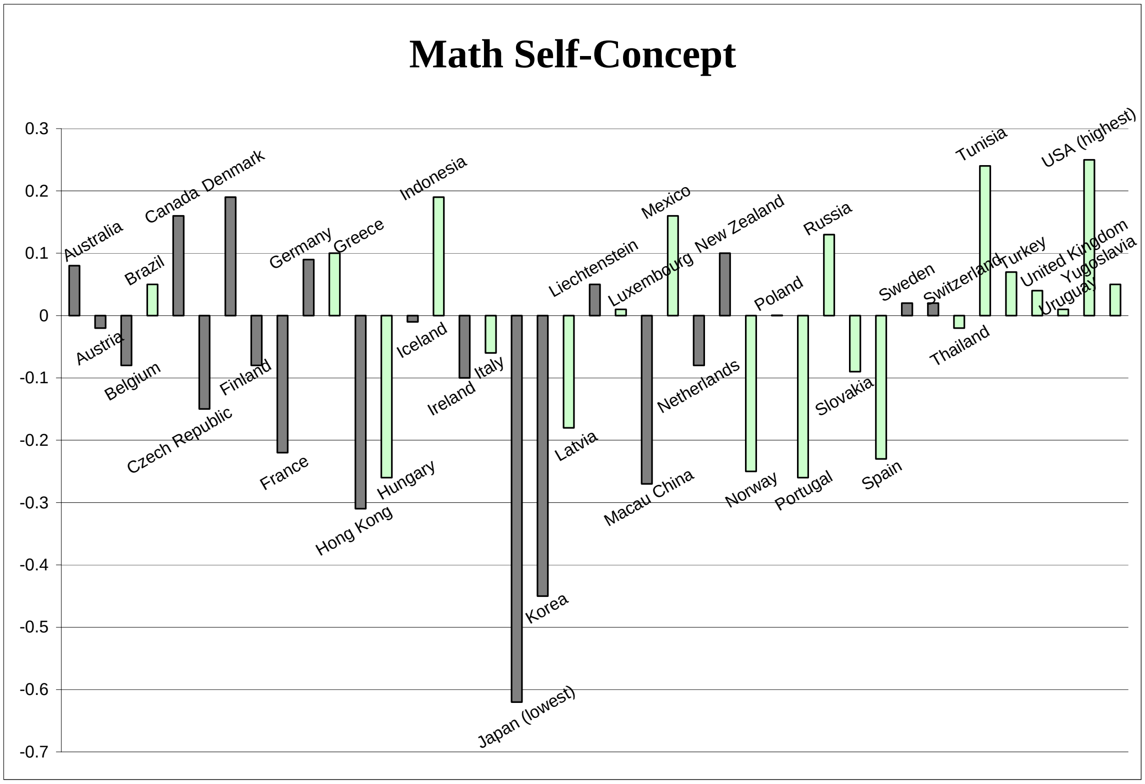

Figure A1. **Math self-concept factor means across countries.**

Note. The darker shaded bars are used for the countries showing the Programme for International Student Assessment (PISA) math scores that are above average across all countries.

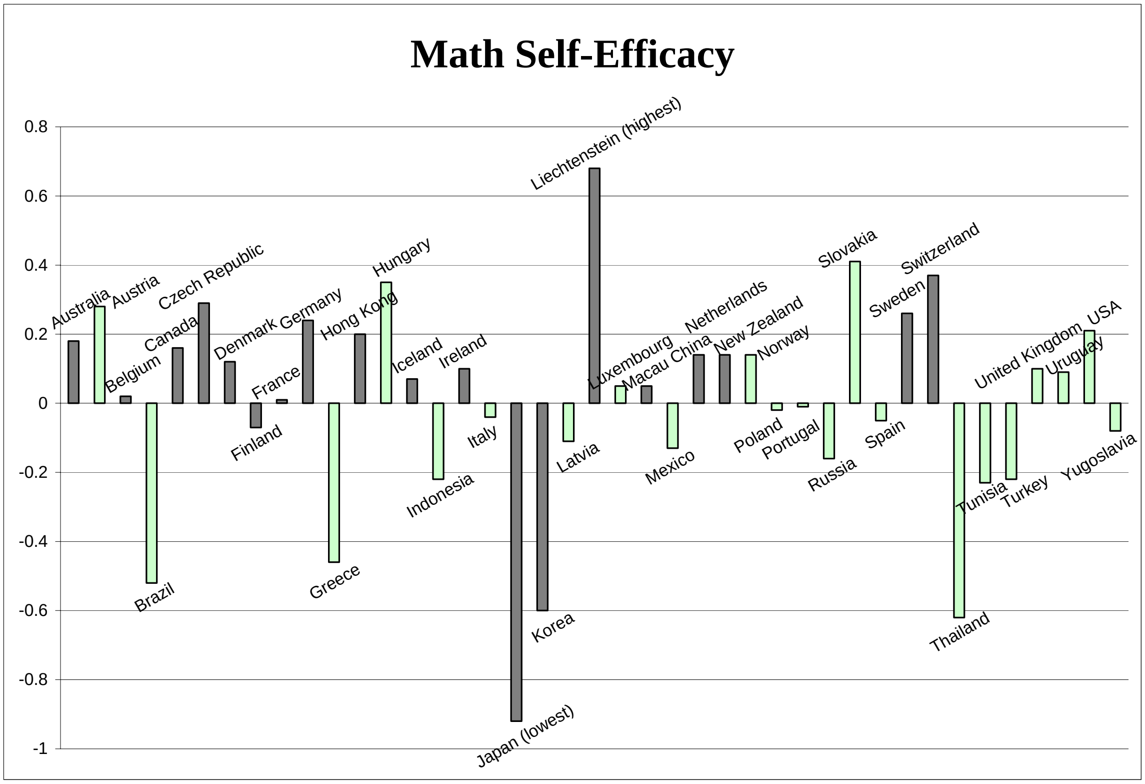

Figure A2. **Math self-efficacy factor means across countries.**

Note. The darker shade bars are used for the countries showing the Programme for International Student Assessment (PISA) math scores that are above average across all countries.

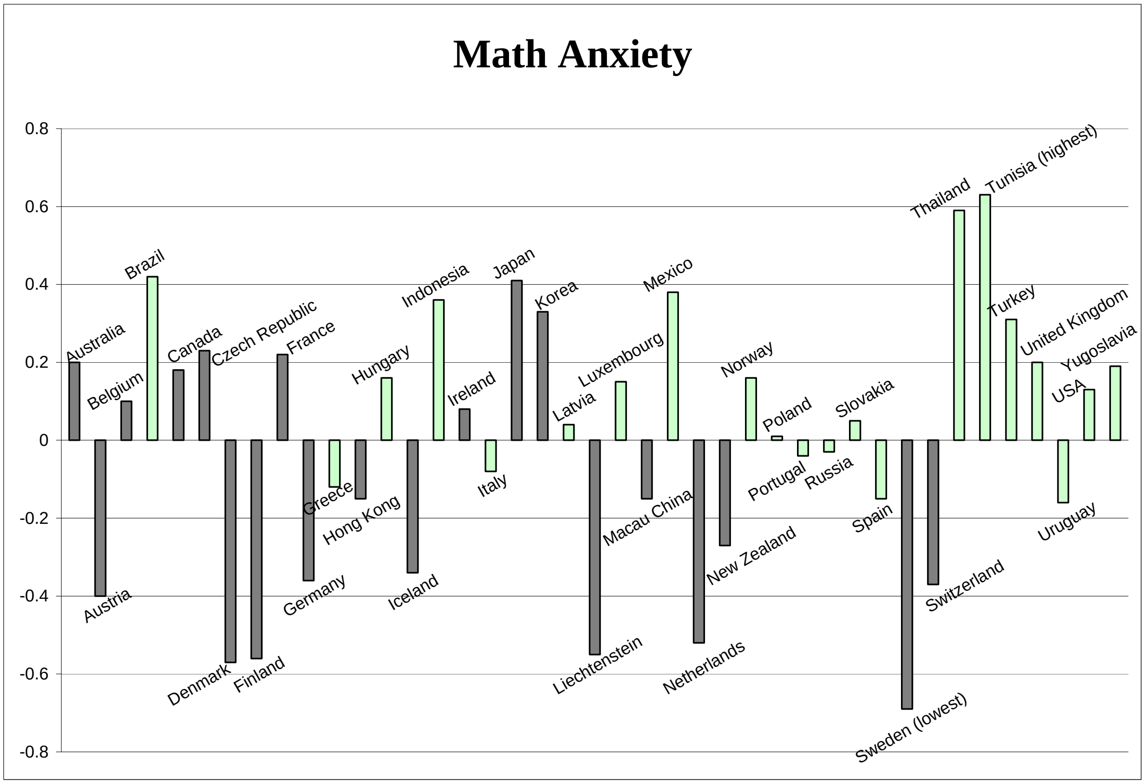

Figure A3. **Math anxiety factor means across countries.**

Note. The darker shade bars are used for the countries showing the Programme for International Student Assessment (PISA) math scores that are above average across all countries.