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A Trend Study of Self-Concept and Mathematics Achievement in a Cross-Cultural Context

Jianjun Wang
California State University

The TIMSS 1995, 1999, and 2003 data have been gathered from Hong Kong before and after its sovereignty switch from the United Kingdom to China in 1997. Built on a reciprocal relation theory from the research literature, this investigation is designed to examine models of student self-concept and mathematics achievement during the political transition. Along with a perceived 'brain drain' from the population migration, there was a non-monotonic change in the reciprocal relationship between self-concept and mathematics achievement. In addition, indicators of mathematics achievement and self-concept have demonstrated different linkages to the permanent emigration of Hong Kong residents with valued or desirable skills and qualifications. Interpretation of these empirical findings entails a need of enhancing cross-cultural understanding in mathematics education.

Professional organisations of mathematics education have attached great importance to affective factors (e.g., National Council of Teachers of Mathematics, 1998). Marsh and Craven (1997) maintain that "enhancing a child's academic self-concept is not only a desirable goal but is likely to result in improved academic achievement as well" (p. 155). The anticipated improvement of student performance is based on the existence of a reciprocal relationship between self-concept and academic achievement (Marsh, Trautwein, Ludtke, Koller, & Baumert, 2005). It has been noted that "[i]n academic self-concept research, support for the main theoretical models has been based largely on responses by students from Western countries, particularly English-speaking students in Australia, Canada, and the United States" (Marsh, Hau, & Kong, 2002, p. 728).

To facilitate the development of new knowledge, the aim of this investigation is to examine the reciprocal relation model through an analysis of empirical data during a cross-cultural transition in Hong Kong. To date, the only comparative project that has gathered large-scale data in mathematics and science education is TIMSS, an acronym originally given to the *Third International Mathematics and Science Study* in 1995 (TIMSS 1995), and the *Trends in International Mathematics and Science Study* that includes TIMSS 1995, 1999, and 2003 projects. The trend data were collected in a parallel pattern to ensure that the results are comparable over the eight-year span (1995-2003). This study is focused on mathematics education because of its universal importance in secondary schools.

Among the TIMSS participating nations, the only nation that has experienced a dramatic political transition in this period is Hong Kong. When the TIMSS data were first collected in 1995, Hong Kong was a British colony. After Hong Kong's handover to China in July 1997, follow-up data were gathered twice in 1999 and 2003. The ongoing political change provides a unique opportunity to examine whether models of the relationship between academic

self-concept and achievement differ from the Western models. Accordingly, this empirical investigation has incorporated both exploratory and confirmatory inquiries. On the exploratory aspect, this investigation includes variables from the Hong Kong context using the large-scale TIMSS database. In addition, grounded in the current literature, this study is designed to reconfirm/disconfirm generalisation of the reciprocal relation model during the period of political transition.

Literature Review

Self-concept is an important construct in education because of its linkage to academic achievement (Byrne, 1984; Valentine, Dubois, & Cooper, 2004). Nonetheless, a general self-concept might not be solely confined in the academic orientation (Skaalvik & Skaalvik, 2006). To facilitate research in education, Shavelson, Hubner, and Stanton (1976) proposed a hierarchical model that divided the general self-concept into academic and nonacademic components. "Recent research has shown a causal relationship between [academic] self-concept and subsequent achievement and that this relationship is reciprocal in nature" (Lau, Yeung, & Jin, 1998, p. 1). Interpretation of the reciprocal relationship has been delineated in the following way — while better student achievement leads to improvement of self-concept, positive self-concept can help increase student achievement concurrently (Byrne & Shavelson, 1986; Craven, Marsh, & Burnett, 2003).

Paradox of the Empirical Evidence

Support for the reciprocal effects model has been found from meta-analyses (Ma & Kishor, 1997; Valentine, Dubois, & Cooper 2004), but this literature was primarily rooted in North American culture. Meanwhile, empirical investigations in comparative education did not produce conclusive findings in a multicultural context. Wilkins, Zembylas, and Travers (2002) analysed international data from the Third International Mathematics and Science Study (TIMSS), and reported a positive relationship between self-concept and mathematics achievement for 16 different countries. Kifer's (2002) analysis indicated that many of the highest performing countries had some of the lowest overall beliefs in student self-ability. Given the involvement of various confounding variables from different cultures, the lack of comparability becomes a concern for cross-sectional comparisons across different nations (Bracey, 2006).

To confront this paradox, Hong Kong is a preferred choice of study because of the dramatic social changes within the recent decade. The TIMSS data were gathered during this transition period across the British and Chinese governance, and thus, empirical investigations can be conducted to examine educational outcomes that are sensitive to the cross-cultural transformation. Trend data analysis at the same location not only reflects the need for reconfirming the reciprocal relation model in Hong Kong, but also alleviates the comparability issue undermining most international studies among different sites.

Identification of Self-Concept

When describing self, one may use words "I" and "me." Naturally, the "I" and "me" perspectives of self have played important roles in self-concept identification (Mead, 1913). While the "I" perspective portrays the self as a doer, the "me" standpoint is needed to gain an understanding of self as object (James, 1890). Because "individuals are capable of forming biased (optimistic or pessimistic) appraisals of their competence" (Martin & Debus, 1998, p. 518), indicators of self-concept from the doer and object aspects can help triangulate the information from different viewpoints, and thus, avoid potential mistakes using a single indicator from one perspective (Bennett & Sani, 2004; Breckler & Greenwald, 1986; Greenwald, 1982).

Similar to the two-side view of self, Marsh (1990) suggested a two-point framework to guide analyses of self-concept: (1) intra-individual comparisons (internal frame of reference), in which students compared their own achievements in one subject with their achievements in other subjects; and (2) social comparisons (external frame of reference), in which students associated their own achievements with those of their classmates. The internal and external structures are closely aligned with identification of self-concept from the doer and object aspects in this investigation.

As a doer, students may assess whether they are good at a subject area according to the internal frame of reference. For instance, Wilkins (2004) employed an item, 'I usually do well in mathematics', from TIMSS to indicate self-concept. He asserted that "based on the operative definition of mathematics and science self-concept, the statement 'I usually do well in mathematics (science)' represents a substantively valid measure" (Wilkins, 2004, p. 345). Still, the single item approach might be too simplistic because of missing indicators from the object aspect.

To address this issue, the external frame of reference can be employed to enrich the self-concept configuration. As Walshaw (2007) has pointed out, "Identity is a social construct" (p. 93). Besides an individual impression of self-strength, students could develop their academic self-concept externally through a comparison with their classmates. During the TIMSS data gathering, students had a chance to rank their acceptance of a statement, 'Math is more difficult for me than for others' (Item name: BSBMTCLM). This external comparison has portrayed self-concept from an object perspective, reflecting the relative difficulty students endured from mathematics learning.

In summary, self-as-doer and self-as-object are two interrelated aspects that fit the historical literature (e.g., James, 1890) and Marsh's (1990) internal/external framework. The doer indicator is based on past analyses of the TIMSS database (Wilkins, 2004). The object indicator further incorporates an external social comparison to facilitate the self appraisal. In support of this empirical investigation, those indicators have been chosen from the TIMSS database to gain both I- and me-perspectives of self-concept in relation to Hong Kong's specific circumstances.

The Hong Kong Context

The cross-cultural context has made Hong Kong an ideal setting for investigating the composition of self-concept (Marsh, Hau, & Kong, 2002; Hau, Kong, Marsh, & Cheng, 2000). One of the intrinsic variables is the co-existence of English and Chinese instruction in mathematics education. Nonetheless, based on the school language labeling, Marsh, Hau, and Kong (2002) reported that "the inclusion of the language-of-instruction variables had almost no effect on the support for the reciprocal effects model" (p. 748). In part, this could be because "a substantial proportion of schools which claimed to teach in English actually taught either in Cantonese or in mixed code" (Bray, 1997, p. 163).

Instead of involving the subtle language factor, this new investigation has designated its focus on substantial changes during the sovereignty switch from Britain to China. Since an initial announcement of the Sino-Britain agreement on Hong Kong's future in 1984, many Hong Kong residents have decided to move abroad (Kingsley & Shirley, 2000). "Because of its rapid growth and sheer magnitude, the effects of emigration from Hong Kong have attracted much attention in recent years" (United Nations Educational, Scientific and Cultural Organisation [UNESCO], 2003, p. 7). Although no researcher has summarised the total emigrant numbers to all western countries, the massive emigration from Hong Kong to Australia has been tracked in Mar's (2002) doctoral thesis. At the peak of the political change, the number of emigrants to Australia in 1994/95 and 1995/96 was 10 times larger than the figure for 1997/98 (Mar, 2002, p. 101). The 1996 census data from Australia further indicated that 32 per cent of Hong Kong born people had 'higher qualifications', about twice the level for the total Australian population (The Department of Immigration & Multicultural Affairs, 2000). "For a brief time, Hong Kong became the number one source of Australian immigrants, surpassing the United Kingdom" (Mar, 2002, p. 105). As a result, a more profound issue behind the political transition was "the outmigration of doctors, bankers and other professionals in a large-scale brain drain" (Mondejar, 2001, p. 1).

The impact of population migration was non-monotonic because of the emigrant return between 1999 and 2003. Goldstein (1999) reported, "The Chinese immigrants [to the western countries] of the past few years, I heard a lot of them say that they will return to Hong Kong ..." (p. 116). Despite the initial drop of parental education in 1999, the returned population tide could have reversed the trend (Goldstein, 1999; Koo, Kam, & Choi, 2003; Rao & Yuen, 2001), resulting in an increase of parental education levels in 2003.

Whereas two points on the time dimension are sufficient to determine a monotonic, linear relationship, the non-monotonic trend is curvilinear in nature, and requires more data points to describe the transition pattern. Therefore, the TIMSS 2003 data are incorporated with the previous two waves of data from TIMSS 1995 and 1999 to disentangle the non-monotonic trend of parental education within the context of Hong Kong.

In summary, the importance of studying the reciprocal relation model in Hong Kong has been recognised by several researchers (e.g., Marsh et al., 2002; Wang, J., 2004; Wang, 2005; Wang, Oliver, & Garcia, 2004). The model examined

in this new investigation differentiates from the past models in at least two distinct aspects: (1) It replaces the ambiguous *school language labeling* with a more pertinent factor of *parental education* to better represent the Hong Kong context in this period; (2) It incorporates the TIMSS 2003 data to support an analysis of the non-monotonic trend that requires at least three waves of data on the time dimension.

Besides the linkage between family background and self-concept (Orr & Dinur, 1995), it has been generally reported that "better-educated parents have children who score higher on tests" (Bracey, 1998, p. 629). Thus, parental education is a profound factor influencing development of student self-concept and academic achievement (Eccles & Harold, 1993; Nakagawa, 2000; Pena, 2000). Because the TIMSS 2003 data were unavailable to the general public until the end of May, 2005, previous studies could not examine this non-monotonic pattern (e.g., Wang, J., 2004; Wang, 2005; Wang, Oliver, & Garcia, 2004; Wilkins, 2004). In this regard, this investigation is built on a solid theoretical framework and pertinent empirical data to enrich the existing knowledge base.

Research Questions

According to Marsh et al. (2002), "Previous research suggests that Chinese students differ from Western students in ways that may be relevant to how they construct their self-concepts" (p. 728). Hong Kong is the only Chinese region that has participated in all three phases of the TIMSS data collection. The trend data at the 8th grade provide a unique opportunity to investigate changes in the relationship between student self-concept and mathematics achievement in light of the fluctuation of parental education levels during the political transition. Research questions that guide this investigation are:

1. How does the change of parental education relate to development of student self-concept and mathematics achievement, respectively?
2. Given the ongoing change of parental education during the political transition, what is the relationship pattern between self-concept and mathematics achievement?
3. Has the statistical modeling been supported by the TIMSS 1995, 1999, and 2003 data across the 8-year period?

Method

Indicator Selection

When variables are not directly observable, researchers tend to use *indicators* or *observed variables* to identify features of the latent variables (see Loehlin, 1992). In this study, self-concept is represented by indicators from the doer and object aspects. The use of multiple indicators is designed to achieve a better representation of the latent variable, and facilitates assessment of potential measurement errors in the statistical computing. According to Schumacker and Lomax (1996), "Today, it is commonly accepted that multiple observed variables are preferred over a single variable in defining a latent variable" (p. 55).

Based on the theoretical framework, self-concept can be disentangled on the intra-individual and social comparison dimensions (Marsh, 1990). From the intra-individual reflection, students answered a TIMSS item, 'I usually do well in mathematics', with a response from "strongly agree" to "strongly disagree" (Wilkins, 2004). In terms of the social comparison, students responded an item 'math is more *difficult* for me than for others' in the TIMSS 1999 and 2003 projects. In the TIMSS 1995 questionnaire, however, the item was worded in reverse with respect to whether mathematics was relatively easy for a student. To maintain consistency in the result interpretation, the scale has been transformed so that a higher ranking response corresponds to a lower difficulty level, and thus, a more positive self-concept.

To represent mathematics achievement more adequately, indicators of academic performance have been selected according to the original TIMSS project design. In particular, each student took a subset of the mathematics test to reduce the testing burden, and a total of five plausible scores have been imputed to estimate the overall student achievement (Wang, 2001). TIMSS researchers suggested that the results from the five plausible scores be averaged for statistical reporting to decrease uncertainty from the multiple score imputations (http://isc.bc.edu/timss1999i/pdf/T99_TR_Chap14.pdf). This method has been adopted in other similar projects, such as the *National Assessment of Educational Progress* (e.g., Allen, Carlson, & Zelenak, 1999). In this investigation, the five plausible scores from TIMSS 1995, 1999, and 2003 projects are employed as indicators of student mathematics achievement.

Statistical Modelling

"The representation of latent variables based on their relation to observed indicator variables is one of the defining characteristics of SEM [Structural Equation Modelling]" (Garson, 2005, p. 3). The SEM analysis can be handled by a computer software package of the Linear Structure Relation (LISREL) (Jöreskog, Sörbom, Toit, & Toit, 2000). More importantly, the LISREL software can model the relationship using indicators on an ordinal scale (Jöreskog, 1990), such as the ones involved in the self-concept identification.

The model of the relationship between student self-concept and mathematics achievement has been depicted in Figure 1. Parental education is a contextual factor reflecting the non-monotonic trend of 'brain drain' during the transition period. Path coefficients (γ_1 & γ_2) are estimated to assess linkages from parental education to student self-concept and mathematics achievement, respectively (Question 1). A correlation coefficient (β) has been computed by the LISREL software to assess the reciprocal relationship between self-concept and mathematics achievement (Question 2). Like a regular correlation coefficient, a strong relationship is represented by a β value near 1, and a weak relationship is indicated by a β value close to zero. The model-fitting indices are calculated to examine the model reconfirmation by the TIMSS 1995, 1999, and 2003 databases (Question 3). To keep Figure 1 more readable, measurement errors considered in

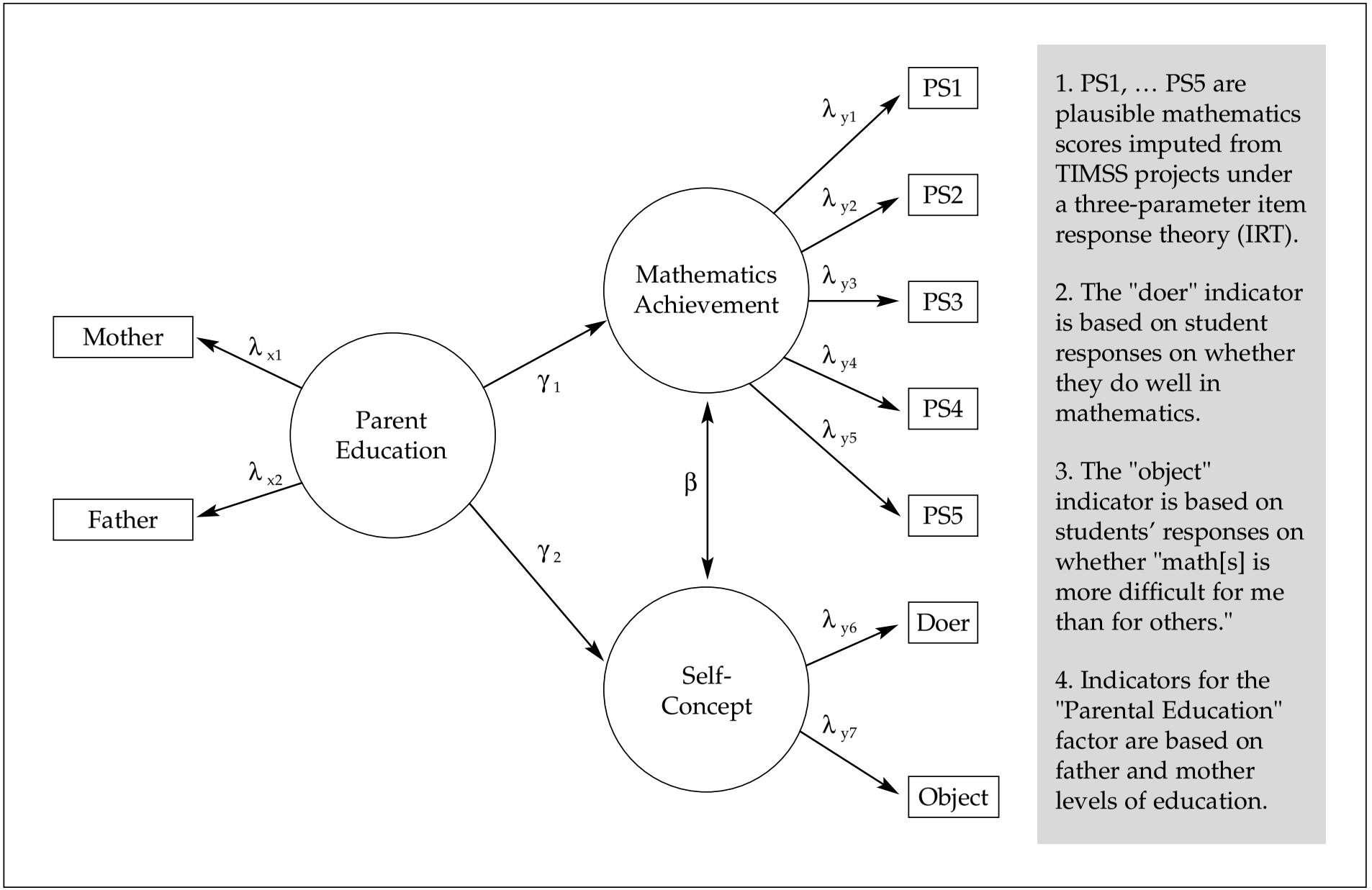

Figure 1. A structural model of self-concept and mathematics achievement from TIMSS.

this investigation are not portrayed along with factor loadings (λ), path coefficients (γ), and correlation coefficients (β).

Based on features of the secondary data analysis, the following two limitations should be acknowledged in this method section:

1. Although *doer* and *object* indicators have been identified to represent the intra-personal and social dimensions of self-concept, the cultural determinants or influences could be too extensive to cover in the TIMSS survey. The drawbacks of relying solely on quantitative analyses should be acknowledged. Based on the ongoing changes of influence from British to Chinese cultural values, more ethnographic research from the qualitative paradigm may help disentangle the apparent switch of student self-concept during the TIMSS investigations.
2. The TIMSS data analyses might seem unfamiliar because of the involvement of sophisticated multivariate methods. For instance, mathematics performance is represented by multiple plausible scores (Gonzalez, & Smith, 1997; Martin, Mullis, Gonzalez, & Chrostowski, 2004), and Greek letters have been employed to present results of the Structural Equation Modelling (SEM). Consequently, the findings with subscripts might appear alien to some readers.

Results

Levels of father or mother education range from completing primary school to finishing university degrees. According to the original TIMSS codes, the parental education indicators have a value of 1 for the lowest education and 6 for the highest education. Sample sizes involved in the statistical computing have been listed in Table 1 along with the average education levels and the corresponding standard errors. The standard error calculation is based on the Jackknife procedure recommended by a TIMSS report (Gonzalez & Smith, 1997). Because of the relatively small standard errors, differences in the average level of education are significant at $\alpha = 0.05$.

The five plausible scores were more or less equivalent in the TIMSS project design to jointly identify student mathematics performance (Gonzalez & Smith, 1997). This design feature was reconfirmed by empirical findings from this

Table 1
Trend in education levels of parents

Project	Father			Mother		
	N	M	SE	N	M	SE
TIMSS95	4961	4.26	0.049	4978	3.93	0.042
TIMSS99	6251	2.89	0.061	6304	2.60	0.053
TIMSS03	4929	4.69	0.060	4930	4.22	0.053

investigation, as illustrated by the almost identical factor loadings (λ_{y1}, λ_{y2}, λ_{y3}, λ_{y4}, and λ_{y5}) within each of the TIMSS databases (Table 2). In contrast, the doer and object indicators seem to have different factor loadings ($\lambda_{y6} \neq \lambda_{y7}$) that need to be addressed in the Discussion section.

Unlike the non-monotonic fluctuation of λ_{y6} and λ_{y7} values, father education has consistently shown more contributions than mother education in identifying the contextual factor of parental education ($\lambda_{x2} > \lambda_{x1}$) across the three databases (Table 2). Furthermore, as the reciprocal relationship remained weak ($\beta \leq 0.03$) on the time dimension, the parent education factor seemed to have demonstrated a stronger link to student achievement than to self-concept ($0.17 \leq \gamma_1 \leq 0.23$; $0.07 \leq \gamma_2 \leq 0.14$).

Whereas the literature review justified appropriateness of using the TIMSS 1995, 1999, and 2003 data to study the reciprocal relation model, the statistical analysis has provided more empirical evidence to assess the model fitness. In particular, *s* (GFI) have been listed in Table 3 to indicate plausibility of fitting the reciprocal model (Figure 1) to the empirical data, and the *root mean square errors of approximation* (RMSEA) are computed to assess the average of residuals not accounted for by the model. The high GFI indices and small RMSEA values reconfirm the model fitness to the trend data from TIMSS.

Table 2
Parameter estimates for the reciprocal model using the TIMSS and TIMSS-R databases

Estimates	TIMSS 1995	TIMSS 1999	TIMSS 2003
Factor pattern coefficients			
λ_{y1}	0.96	0.92	0.96
λ_{y2}	0.95	0.93	0.96
λ_{y3}	0.95	0.93	0.96
λ_{y4}	0.96	0.92	0.96
λ_{y5}	0.96	0.93	0.96
λ_{y6}	1.16	0.56	0.68
λ_{y7}	0.41	0.75	0.71
λ_{x1}	0.78	0.63	0.66
λ_{x2}	0.84	0.69	0.93
Reciprocal Relation			
β	0.01	0.03	0.01
Path Coefficients			
γ_1	0.19	0.23	0.17
γ_2	0.07	0.14	0.07

Table 3
Model fitting indices for the TIMSS and TIMSS-R databases

Indices	TIMSS 1995	TIMSS 1999	TIMSS 2003
RMSEA	0.06	0.07	0.07
GFI	0.98	0.97	0.97

Discussion

This empirical investigation is based on a careful selection of timing and location to examine the reciprocal relation model in a cross-cultural context. The timing has been designated to a special period in which the TIMSS 1995, 1999, and 2003 data are available for statistical analyses. The Hong Kong location is unique for its sovereignty handover between Britain and China during the same period. Accompanied by the migration of professionals *in* and *out of* the territory, a non-monotonic change of parent education has been found in the local school setting (Table 1). Discussion of the empirical findings is grounded in this context to disentangle the empirical relationship between student self-concept and mathematics achievement using the TIMSS databases from more than 15,000 students.

Empirical Trends within the Hong Kong Context

During the 8-year trend study, parental education levels have decreased from TIMSS 1995 to TIMSS 1999 projects, and bounced back in the TIMSS 2003 project (Table 1). Despite this fluctuation, what remained consistent was a gender difference in the influence of parental education. In particular, father's education seemed to have more contribution to the *parental education* factor than mother's education ($\lambda_{x2} > \lambda_{x1}$). The cultural heritage might have played an important role since "The traditional Chinese culture is male-oriented culture" (Wong, Lam, & Ho, 2002, p. 830). More than 2000 years ago, Confucius downplayed the importance of female education, and maintained that "a woman is virtuous only if she is untalented" (cited by Lin, 2001, p. 159).

When the modernisation drive was launched in China after the Cultural Revolution, implementation of a single-child policy has deterred two or more children families (Wang & Brie, 1997); but the single-child policy was confined within the mainland China. Without the population control measure in Hong Kong, the male-dominant culture not only adored boys, but also elevated the father's status. Consequently, the TIMSS results demonstrated more contribution from fathers' education than mothers' to the category of parental influence.

Figure 1 illustrates empirical linkages from parental education to student learning outcomes. Typically, "Hong Kong Chinese parents carried and penetrated in their home environment their attitudinal emphasis in their children's academic success" (Wang, D., 2004, p. 52). Whereas a self-concept has

been derived from a theoretical framework (Marsh, 1990), student achievement is simply represented by mathematics scores. Due to the transparency of score monitoring, it is no surprise to observe a larger path coefficient from the parental education factor to the *academic achievement* outcome (i.e., $\gamma_1 > \gamma_2$). This finding also reflects education values of Hong Kong parents because "Excellent examination results are considered representative of the status and good reputation of the family" (Lau, Yu, Lee, So, & Sung, 2004, p. 22).

According to the research literature, English-speaking nations place more emphasis on individualism, and "Chinese culture is low on the culture value of individualism and high on collectivism" (Marsh, Hau, & Kong, 2002, p. 728). In identifying self-concept, the doer perspective is linked to individual judgment as to whether or not a student performs well in mathematics. The object perspective, on the other hand, is based on a comparison of academic performance among students. In the TIMSS 1995 project, the indicator from the doer's perspective had a stronger influence than the comparative considerations from the object perspective ($\lambda_{y6} > \lambda_{y7}$) (see Table 2 & Figure 1). After the sovereignty handover, the results were reversed, and the social comparison played a more important role ($\lambda_{y6} < \lambda_{y7}$) in the TIMSS 1999 and 2003 projects. Consistent with the transformation from British to Chinese governance, this change seems to indicate a switch of influence from the individual viewpoint to the collective consideration in self-concept identification.

Non-Monotonic Changes During the Transition

It should be noted that the fluctuation of parental education was parallel to the tide of population migration in this period (see Goldstein, 1999; Mar, 2002; Rao & Yuen, 2001). As the parental education factor reached the lowest level in 1999 (Table 1), the shortage of human resources might have generated more family awareness to the 'brain drain' issue, and thus, higher path coefficients (i.e., γ_1 or γ_2) appeared in TIMSS 1999 (Table 2). In line with the stronger influence of parental education on mathematics achievement and self-concept, the East Asian financial crisis in 1999 also triggered more education demands on core subject training (Yam, 1999). These contextual factors might have jointly contributed to a non-monotonic fluctuation of the γ_1 and γ_2 values along with the sovereignty transformation (Table 2).

In response to this curvilinear change, the strongest reciprocal relationship between mathematics achievement and self-concept has also been obtained from the TIMSS 1999 project ($\beta = 0.03$). On a scale between 0 and 1, however, even this largest β value was too small to claim a substantial implication. The influence of both British and Chinese cultures might have resulted in overlooking a strong reciprocal relationship reported from the western literature (see a summary by Ma & Kishor, 1997). On the one hand, positive reciprocal relationships have been found from studies of English-speaking population (Valentine, Dubois, & Cooper 2004), and Hong Kong had the British influence during its 150-year colonial history. On the other hand, Confucius stated that "The more a man

learns, the more he knows his ignorance" (http://novel.jschina.com.cn/yingyuwenxue/yinghmy/yinghanmingyan15.htm, p. 1). Therefore, one might speculate a negative reciprocal relationship between mathematics achievement and self-concept due to Confucius ideology in Chinese tradition. As the positive and negative relationships counter-balanced each other, a weak reciprocal relationship has been found from this investigation (see the β values in Table 2).

Model Fitting Indices

Because this investigation is deeply grounded on the existing literature, it is important to confirm that the theoretical model has a strong support from the empirical databases. Jöreskog and Sorbom (1993) maintained that an appropriate model should have a small *Root Mean Square Errors of Approximation* (RMSEA) and a large *Goodness of Fit Index* (GFI). In terms of either criterion, the results in Table 3 clearly suggest strong support of the statistical model from the trend databases.

Sharma (1996) cautioned that the model-fitting indices could be "affected by sample size" (p. 158). In this study, invariant model-fitting indices have been obtained from trend data analysis (Tables 1 & 3) despite the variation of sample sizes in the TIMSS 1995, 1999, and 2003 databases. Consistency of the model-fitting indices clearly suggested a constant support of the theoretical model across the transition period between British and Chinese governances.

In conclusion, a weak relationship has appeared between mathematics achievement and self-concept during the cross-cultural transition. "In an interconnected world, understanding other nations and regions is a cornerstone of democratic citizenship" (Engler, Hunt, & James, 2004, p. 199). To enhance understanding of the cultural diversity, more investigations are needed to further disentangle the feature of mathematics achievement and self-concept, and verify the non-monotonous trend along with the weak reciprocal relationship. In this regard, the statistical findings reported in this article do not preclude scholarly inquiries from qualitative paradigm to enrich the cross-cultural understanding of mathematics education during the special period of sovereignty transition.

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Author

Jianjun Wang, Department of Advanced Educational Studies, California State University, Bakersfield, 9001 Stockdale Highway, Bakersfield, CA 93311-1099, USA. Email: <jianjun_wang@firstclass1.csubak.edu>