Testing the Internal/External Frame of Reference Model of Self-Concept with Chinese High School Students in Talented and Nontalented Classes

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Abstract

This study examined the internal/external frame of reference (I/E) model (Marsh, 1986) with Chinese students in "accelerated" talented (n = 160) and "average" talented (n = 335) classes. Confirmatory factor analyses showed support for the I/E model for students placed in "accelerated" and "average" classes in a talented high school. Path coefficients leading from Chinese achievement score to verbal self-concept and from maths achievement score to maths self-concept were positive and significant whereas paths relating nonmatching domains were negative, although the sizes of the effects differed across the two groups. The results support the multidimensionality and content specificity of academic self-concept.

Recent research on self-concept has emphasised domain-specific and multidimensional perspectives that are in contrast to traditional views of a global composite self-concept that was assumed to explain

self-concepts in various areas (e.g., Byrne, 1984; Marsh, 1993; Marsh, Byrne, & Shavelson, 1988; Marsh & Yeung, 1997). Shavelson, Hubner, and Stanton (1976) proposed a hierarchical multidimensional model of self-concept that posited a general (global) self-concept at the apex under which were academic and nonacademic self-concepts which were further divided into domain specific areas such as Verbal and Maths self-concepts. However, further evaluations of this model found that Verbal and Maths self-concepts were nearly uncorrelated (e.g., Marsh, 1986; Marsh, Byrne, & Shavelson, 1988); hence Verbal and Maths self-concepts could not be combined to form a higher-order Academic self-concept factor. Marsh (1986) further demonstrated that Verbal and Maths self-concepts are distinct constructs. Thus a student having a high self-concept in maths does not necessarily have a similarly high verbal self-concept. In an attempt to explain these consistent findings over several studies, Marsh (1986) developed the internal/external frame of reference (I/E) model. Although some studies have demonstrated the generalisability of the I/E model, less work has been done to examine the applicability of the I/E model in an eastern culture, and particularly to talented students. The present investigation examines the applicability of the I/E model with high-ability students in China.

According to the I/E model, Maths and Verbal self-concepts are influenced both by external and internal comparisons. The external frame of reference involves comparing the student's perceived academic ability with the abilities of other students in a specific environment (e.g., school, peer group). The internal frame of reference refers to

the student's comparison of perceived ability in one subject domain with perceived ability in another subject domain. Thus a student whose achievement in Maths is lower than most other students may have a low Maths self-concept due to an external comparison with other students, but may have a relatively higher Maths self-concept than, for example, English self-concept if maths is the student's best among other subjects. The joint effect of external and internal comparisons may then result in a near-zero correlation between Maths and Verbal self-concepts.

Using a confirmatory factor analysis (CFA) approach to test the I/E model, Marsh (1986) demonstrated a positive effect of maths achievement on Maths self-concept and a positive effect of verbal achievement on Verbal self-concept, but a negative effect of maths achievement on Verbal self-concept and a negative effect of verbal achievement on Maths self-concept, and a substantially smaller correlation (approaching zero) between Maths and Verbal self-concepts than the typically large correlation between maths and verbal achievement. Subsequent studies on the I/E model based on the English version of the SDQ instruments have been very supportive of these findings (e.g., Byrne & Shavelson, 1987; Marsh, Byrne, & Shavelson, 1988). Furthermore, apart from Marsh's Australian sample, studies of the I/E model conducted in countries such as Norway (Skaalvik & Rankin, 1995), Spain (Gonzalez-Pienda, Nunez-Perez, & Valle-Arias, 1992) and North America (Tay, Licht, & Tate, 1995) also supported the generalisability of the model.

Various studies have also demonstrated the generalisability of the I/E

model irrespective of the instrument used in the investigations. For example, Marsh , Byrne, & Shavelson (1988) showed consistent support for the I/E model when using different instruments such as the Self Description Questionnaire, Affective Perception Inventory, Self-esteem Scale, and the Self-concept of Ability Scale as well as the combined self-concept scores. Using the Academic Perception Questionnaire, Tay, Licht, and Tate (1995) found patterns that were highly consistent with the I/E model. Similarly, the I/E model was also supported in the Skaalvik and Rankin (1995) study in which measures of self-concept, self-perceived aptitude, and self-perceived ability to learn were combined into single maths and verbal latent traits.

To educational researchers the relationship between academic achievement and academic self-concept has always been an important concern. The I/E model explains, at least partly, the formation of academic self-concept and the relationship between academic self-concept and academic achievement from a multidimensional perspective. Using a sample of 511 students from an "accelerated" class and other "average" classes in a Chinese high school of talented students, we hypothesise that the I/E model should be applicable across abilities as well as across cultures.

In the field of talented education, most previous research involved comparisons of means between gifted and nongifted samples. Relatively little attention has been paid to the structure of self-concept in gifted and talented children (Hoge & McShefrey, 1991). More importantly, as most of the previous research on the self-concept of talented children seemed to have suffered from methodological

problems (Hoge & Renzulli, 1993), findings have been inconsistent and sometimes ambiguous (Kulik & Kulik , 1992). Also, the question of whether a given instrument, such as the Self Description Questionnaire II (SDQII) that is considered here, measures the same components of self-concept with equal validity for talented and average-ability students remained unanswered. Thus, in the present study, the applicability of the Marsh (1986) I/E model to these talented students is an important issue.

Method

Participants

The participants were 511 students (174 in Grade 7, 166 in Grade 8, and 171 in Grade 9) from a prestigious state high school in a province in the southern part of China. In China, although gifted and talented education is not officially emphasised, in some schools, special programs have been set up to meet the needs of high academic achievers. For example, students who participated in the present study were strictly selected on the basis of academic performance. Upon admission after keen competition, they had to attend a streaming test at the beginning of Grade 7 for placement of the most talented in an "accelerated" class (named experimental class). In the "accelerated" class, students usually complete equivalent course work two to three months in advance than the "average" classes. Then, some enrichment programs and extensive courses were provided to these talented students. For the present study, permission to participate in the study was obtained from the students and their parents. Because of

absences and missing data, the following analyses used the responses of 495 students (160 in a "accelerated" class labelled as such and 335 in "average" classes).

The SDQII Measures

The Verbal and Maths self-concept scales of the SDQII (Marsh, 1992) were used in this study. Each SDQ item consisted of 10 items each using a 6-point true-false response scale (1 = false to 6 = true). The items were translated into Chinese by a professional two-way translator and translated back into English by another translator to ensure identical meanings were essentially conveyed by the original and translated versions.

The Exam Scores

Exam scores of Chinese and maths were obtained about a month before the administration of the SDQII instrument. The Grade 9 students had a maximum possible score of 150 in math instead of the 100 for Grades 7 and 8; hence all exam scores are reported in percentages for ease of comparison.

Statistical Analyses

Responses to all negatively worded items were reverse scored so that higher scores reflected higher self-concept. Analyses were conducted with item pair scores; hence the five item pairs for each of two SDQ constructs (Verbal and Maths self-concepts) and achievements of two subjects (Chinese and maths exam scores) yielded a 12 x 12 covariance matrix for CFA. The approach of CFA and the use of item pairs have

been described elsewhere (e.g., Bollen, 1989; Byrne, 1989; Joreskog & Sorbom, 1993; Marsh, 1994; Marsh & O'Neill, 1984; also see Pedhazur & Schmelkin, 1991) and are not further detailed here.

Chinese

.36* Verbal

exam

self

-.11*

.35*

-.06

-.22*

Math

.51* Math

exam

self

Figure 1. Path model relating Chinese achievement and maths achievement to Verbal self-concept and Maths self-concept. Path coefficients shown here are based on solution of model C2 with factor loadings, path

coefficients, and residuals and correlated residuals constrained to be equal across the "accelerated" and "average" groups.

Analyses were conducted with the SPSS version of LISREL (Joreskog & Sorbom, 1988) to test the a priori path structure on the basis of the Marsh (1986) I/E model (Figure 1). The goodness of fit of models is evaluated based on suggestions of Marsh, Balla, and McDonald (1988) and Marsh, Balla, and Hau (1996) with an emphasis on the Tucker-Lewis index (TLI) as well as the chi-square test statistic and the relative noncentrality index (RNI).

Results and Discussion

Preliminary Analysis

Reliability estimates for the SDQII Verbal and Maths self-concept scales are good (alphas = .85 and .91, respectively.) Although not the focus of the present study, students in the "accelerated" group had generally higher maths self-concept (M = 4.69 and 4.29, respectively) and also higher verbal self-concept though to a lesser extent for most items (M = 3.90 and 3.80, respectively) than those in the "average" group. Not surprisingly, both the Chinese and maths exam scores were higher in the "accelerated" group (M = 81.02 and 83.11, respectively) than in the "average" group (M = 76.42 and 78.59, respectively). Even so, it is interesting to note that these mean exam scores are remarkably high even in the "average" group for high school students, reflecting the stringent selective criteria for high-ability students in this particularly prestigious school in the province.

Model A: Using The Total Sample

The first model considered the total sample of students (N = 495). Paths between latent variables were posited as shown in Figure 1 and the pattern of paths applied to all of the following analyses, although only the solution of a 2-group invariance model is presented at Table 2. A summary of the goodness of fit and path coefficients for each model considered here is given at Table 1. The total-sample model converged to a proper solution with a reasonably good fit (TLI = .952, RNI = .964). Consistent with the I/E model (Marsh, 1986) the path coefficient of the path from maths exam to Maths self-concept (.52) was positive and significant whereas that from maths exam to Verbal self-concept was negative and significant (-.22). Also, the path from Chinese exam to Verbal self-concept (.37) was positive and significant but the path from Chinese exam to Maths self concept, though negative as expected, was not significant (-.08). The magnitude of positive paths between matching academic domains tended to be greater than the negative paths between nonmatching domains. More interestingly, coefficients of the positive paths tended to be greater than those typically found using the English version of the SDQ instruments (e.g., Byrne & Shavelson, 1986; Marsh, 1992).

Model B: The "accelerated " group. This model considered only students in the "accelerated" group (n = 160). The model converged to a proper solution with a reasonably good fit (TLI = .937, RNI = .952). The path from maths exam to Maths self-concept (.25) was positive and significant whereas that from maths exam to Verbal self-concept was negative and significant (-.19). However, the paths from Chinese exam

to Verbal self-concept (.11) and from Chinese exam to Maths self-concept were not significant (-.09) although the direction of the signs was consistent with the I/E model. The path coefficients were comparatively small in size in the "accelerated" group.

Model B: The "average" group. This model considered only students of "average" group (n = 335). The model converged to a proper solution with a reasonably good fit (TLI = .954, RNI = .965). Consistent with the I/E model (Marsh, 1986) the paths from maths exam to Maths self-concept (.66) and from Chinese exam to Verbal self-concept (.49) were both positive and significant whereas paths from maths exam to Verbal self-concept (-.29) and from Chinese to Maths self-concept (-.19) were both negative and significant. The sizes of the positive paths were greater than the negative paths, and the sizes of all paths were greater than those in the "accelerated" group.

As stated in earlier review, the I/E model predicts that due to the external frame of reference, students compare their academic achievement in each domain with those of other students; thus Maths and Verbal self-concepts should be substantially correlated as are the academic achievements in these two subjects. Thus high ability in maths would lead to higher Maths self-concept whereas high verbal achievement would lead to higher Verbal self-concept. However, because of the internal frame of reference, students compare their performance in one area with their own performance in another area, and as a consequence, good maths achievement would lead to lower Verbal self-concept and good verbal achievement would lead to lower Maths self-concept. The results of Models A and B provided support for this notion, although the paths

from achievement to non-matching self-concept domains in the "accelerated" group were not significant, suggesting that the internal reference (i.e., self-comparison of subject domains) may not be as strong in the extremely talented group as in the "average" talented students. Thus, we used the multiple-sample analyses to assess the ability difference.

Model C. To test the factorial invariance between the "accelerated" and "average" groups, we test a series of models with different combinations of constraints to estimated parameters. Methods in testing the factorial invariance are widely discussed are not further detailed here (for more detailed discussion, see Bryne, Shavelson, & Muthen, 1989; Joreskog & Sorbom, 1988). Because our focus is on the invariance of path coefficients across the "accelerated" and "average" groups, the critical models to consider were those that imposed constraints on both the factor loadings and the path coefficients in comparison to other alternative models. The goodness of fit of models that converged to proper solutions is shown in Table 1 (Model C). Models that did not converge to proper solutions are likely to be problematic for interpretations and are thus not reported.

The goodness of fit for Models C1 to C4 is all reasonable and close (RNI ranging from .939 to .944 and TLI ranging from .933 to .937). Because these models are nested, choice of the best fitting model can be done statistically by comparing their (2 values and their df. Typically the choice of a better model than another one requires significant decrease in (2 value with reference to the decrease in df . Otherwise the more parsimonious model (one with fewer estimated

parameters and hence larger df) is chosen. A comparison of the (2 values of the four models considered (section C of Table 1) resulted in our choice of Model C2 as the best fitting model among others (a decrease of (2 value of 22.90 per 10 df compared to Model C1, $p < .05$). The CFA solution for Model C2 is thus presented in Table 2. However, the choice of a best fitting model is not a critical concern in this particular case because the focus is on the path coefficients and incidentally all four models that resulted in proper solutions had the path coefficients constrained to be equal across groups. Thus as long as the models fitted the data, the magnitude and direction of the paths are the critical concern.

In all these four models, the paths between matching domains, i.e., from maths exam score to Maths self-concept and from Chinese exam score to Verbal self-concept, though lesser in magnitude, were positive and significant. In contrast, paths between nonmatching domains, i.e., from maths exam score to Verbal self-concept and, to a lesser extent, from Chinese to Maths self-concept, were negative and significant. These results were consistent with the I/E model, and the invariance models in section C (Table 1) showed that the pattern is reasonably similar across the "accelerated" and "average" groups.

In sum, all the CFA models considered here supported the I/E model. The patterns of path coefficients showed that achievement in a specific academic domain had a significantly positive impact on self-concept in the same academic area; but also had a significantly negative impact on another academic area due to an internal comparison of abilities in these academic areas.

Table 1

Goodness of Fit Summary for Alternative Models and Critical Path Coefficients

Path Coefficients

From

Chin Maths Chin Maths

Model N (2 df RNI TLI GFI Description To

Vsc Msc Msc Vsc

A. All students

Null 495 3113.55 66

Total 495 159.91 50 .963 .951 .950 Total sample

.37* .52* -.08 -.22*

B. Separate groups

Null 160 868.60 66

"accelerated" 160 85.48 50 .952 .937 .920 "accelerated" class .11

.25* -.09 -.19*

Null 335 2314.94 66

"average" 335 128.31 50 .965 .954 .942 "average" class

.49* .66* -.19* -.29*

C. 2-group invariance

Null 160+335

C1. 160+335 311.22 128 .939 .937 .927 FL,PC,R,U inv

.36* .51* -.12* -.22*

C2. 160+335 288.32 118 .943 .937 .932 FL, PC, R inv

.36* .51* -.11* -.22*

C3. 160+335 299.20 120 .940 .934 .928 PC, U, R inv

.36* .51* -.12* -.22*

C4. 160+335 277.92 110 .944 .933 .933 PC, R inv

.36* .51* -.12* -.22*

Note. RNI = Relative noncentrality index. TLI = Tucker-Lewis index. GFI = Goodness-of-fit index. RMSEA = Root mean square error of approximation. FL = factor loadings. PC = path coefficients. U = uniquenesses. R = residuals. inv = invariant. Models that did not converge to a proper solution are not presented here. CFA solution for Model C2 is presented at Table 2.

Table 2

CFA Solution for Model C2

Factor Loadings Uniq

Chin Maths MSELF VSELF

"accelerated" Group (n = 160)

1 Chin 1 0 0 0 0

2 Maths 0 1 0 0 0

3 MSELFP1 0 0 .82* 0 .39

4 MSELFP2 0 0 .73* 0 .34

5 MSELFP3 0 0 .84* 0 .39

6 MSELFP4 0 0 .83* 0 .35

7 MSELFP5 0 0 .89* 0 .17

8 VSELFP1 0 0 0 .79* .38

9 VSELFP2 0 0 0 .70* .59

10 VSELFP3 0 0 0 .78* .39

11 VSELFP4 0 0 0 .76* .54

12 VSELFP5 0 0 0 .66* .66

"average" Group (n = 335)

1 Chin 1 0 0 0 0

2 Maths 0 1 0 0 0

3 MSELFP1 0 0 .82* 0 .30

4 MSELFP2 0 0 .73* 0 .52

5 MSELFP3 0 0 .84* 0 .29

6 MSELFP4 0 0 .83* 0 .28

7 MSELFP5 0 0 .89* 0 .24

8 VSELFP1 0 0 0 .79* .39

9 VSELFP2 0 0 0 .70* .48

10 VSELFP3 0 0 0 .78* .39

11 VSELFP4 0 0 0 .76* .38

12 VSELFP5 0 0 0 .66* .51

Path Coefficients (identical for both groups)

to MSELF -.11* .51*

to VSELF .36* -.22*

Correlations between constructs (identical for both groups)

Chinese --

Maths .35* --

MSELF .07 .47* --

VSELF .28* -.09 -.14 --

Residuals and correlated residuals

Chinese 1

Maths .35* 1

MSELF 0 0 .77*

VSELF 0 0 -.06 .88*

Note. N = 495. The four constructs were Chinese achievement (Chin), Maths achievement (Maths), Verbal Self-concept (VSELF), and Maths Self-concept (VSELF) inferred from 5 item pairs (P1 to P5). Uniq = uniqueness. Parameters with values of 0 or 1 were fixed in the definition of the model. All parameters, except uniquenesses, across the two groups were constrained to be equal. * $p < .05$

Summary and Limitations

The present study examines the applicability of the I/E model of self-concept using a Chinese sample of talented students. The results of this investigation clearly support predictions from the Marsh (1986) I/E model for Maths and Verbal self-concept. Since most previous studies of the I/E model were conducted in western countries, the results of the present study show the strength of the I/E model across cultures. In the present study, the path coefficient from maths exam to Maths self-concept and Chinese exam to Verbal self-concept were significant and positive whereas that from maths exam to Verbal self-concept was negative and significant. However, in the total sample, the path from Chinese exam to Maths self-concept was negative but nonsignificant. When two groups were tested separately, all path

coefficients of the "average" group was consistent with the Marsh (1986) findings. However, for the "accelerated" group, the paths from Chinese exam to Verbal self-concept and Math self-concept were not significant, although they were in the predicted direction. As some researchers (e.g., Byrne & Gavin, 1996) have suggested, measures of verbal achievement and Verbal self-concept are not always as stable as assumed because language may involve a wide range of elements, such as the study of literature, writing, reading skills and grammar, or the combination of these. Nevertheless, an inspection of the models tested in our analyses revealed that the particularly small sizes of negative paths between nonmatching subject domains are found mainly in the "accelerated" group in which the brightest students in the province, or perhaps the highest achievers in the country, are placed. Another limitation which is worthy to note here is that only one single indicator for Chinese and maths achievement (Chinese exam score and math exam score, respectively) was used . In a CFA solution, the problem of using single indicators has been discussed elsewhere. As summarised by Helmke & van Aken (1995), the use of single any indicator does not allow proper tests of the reliability of the indicator and corrections of relations between constructs for unreliability. Nevertheless, in general, the findings of the present study support the applicability of the I/E model with Chinese students, except that for extraordinarily high achievers in both maths and verbal domains, the external frame of reference seems to be more dominant than the internal frame of reference.

To sum up, the present study found that the I/E model based on the

multidimensionality and domain-specificity of self-concept found in Western samples can be generalised to Chinese students. Like other students, talented students generally form their self-concept on the basis of an internal/external frame of reference by comparing themselves with other students in specific curriculum areas as well as between their own performances in these curriculum areas, although the internal frame of reference may not function as strongly as the external frame of reference.

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