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台灣數理教學與學習之文化藝品、信念、知識與策略發展：與PISA和TIMSS結果的關係
研究成果報告(精簡版)

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中 文 摘 要 ： 本研究的目標是探討影響數理成就的自我概念，並力圖整合重「內在比較」的「內外在參照架構」和重「外在比較」的「大魚小池效應」二理論。藉由一系列的「學生/學校/國家」三階層統計分析，以 TIMSS 資料庫為樣本，本研究結果顯示二理論式可穩定有效的整合，特別是對數學而言。

中文關鍵詞： 自我概念、內外在比較、數理成就

英 文 摘 要 ： The aim of this study is to merge internal and external comparisons, which are two of the major sources of academic self-concepts, in relation to math and science achievements. This study was initiated based on the rationales that the internal/external frame of reference (I/E) model is actually based on ‘internal comparison’ and the big-fish-little-pond effect (BFLPE) entirely focuses on ‘external comparison;’ as such, the two theories can be incorporated to supplement each other. The results of a series of student/school/country three-level analyses across 26 countries using the TIMSS database revealed that a stable and valid I/E model was obtained when incorporated with a BFLPE, especially for math.

英文關鍵詞： self-concept； internal and external comparisons, math and science achievements

Sources of academic self-concepts:
Internal and external comparisons between math and science achievements

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Abstract

The aim of this study is to merge internal and external comparisons, which are two of the major sources of academic self-concepts, in relation to math and science achievements. This study was initiated based on the rationales that the internal/external frame of reference (I/E) model is actually based on 'internal comparison' and the big-fish-little-pond effect (BFLPE) entirely focuses on 'external comparison;' as such, the two theories can be incorporated to supplement each other. The results of a series of student/school/country three-level analyses across 26 countries using the TIMSS database revealed that a stable and valid I/E model was obtained when incorporated with a BFLPE, especially for math.

Keywords: self-concept; internal and external comparisons, math and science achievements

Marsh and his colleagues (e.g., Marsh, 2004; Marsh & Hau, 2003, 2004) have long worked on sources of academic self-concepts. Two of the major sources are the psychological processes of *internal* and *external comparisons* in relation to academic *achievements*. *Internal comparison* leads individuals into a comparison of their own relative achievements across domains, e.g., math and verbal skills and an establishment of a self-concept such as 'I am better at math than verbal skills.' On the other hands, *external comparison* leads individuals into a comparison of their own and others' achievements in a setting and an establishment of a self-concept such as 'I am in the top 10% band of math achievement in my school.' The two processes are researched based on two lines of theory: (1) the *internal/external frame of reference (I/E) model* (including both internal and external comparisons) and (2) the *big-fish-little-pond effect* (*BFLPE*) (including only external comparison). A significant number of studies have provided evidence in support of the two theories respectively, e.g., Marsh, Kong, and Hau (2001), Plucker and Stocking (2001) researching the I/E model, and Marsh (1987), Marsh, Chessor, Craven, Roche (1995), and Zeidner and Schleyer (1999) researching the BFLPE. To date there appears only one study aiming to merge these two theories, i.e., Marsh's (1994) study, which successfully provided evidence in support of predictions of both theories; but another statistical method is used in the present study to model the data from several levels (to be further discussed in *Methodological issues)*. The similarity between the theoretical backgrounds of the two theories dictates the possibility that the two theories can be combined to elaborate each other. Furthermore, the I/E model appears to be a more comprehensive theory (including both internal and external comparisons) that can incorporate the conception of the BFLPE (including only external comparison). The major aim of the present study therefore is to posit and examine an extended I/E model, which incorporates the conception of the BFLPE.

The variables for investigation of the I/E model and the BFLPE should include self-concepts and achievements from at least two school subjects, e.g., math and science, and from at least two

levels, e.g., student and country. The Trends in International Mathematics and Science Study (TIMSS) collected all these data. Using TIMSS data, Wilkins (2004) found that there were positive relations between achievements and self-concepts at the student level but negative relations at the country level in a comparison of math and science, which suggests that the TIMSS database can serve as a suitable data resource for the present purpose. Marsh and Hau (2003) provided positive support for cross-cultural generalization of the BFLPE across 26 countries using the data from the Programme for International Student Assessment (PISA). Marsh and Hau (2004) further evidenced the I/E model in a comparison of math and verbal skills using the same database. Using the TIMSS database in math and science can be an extension and another generalization of the I/E model and the BFLPE to different school subjects and samples.

Methodological issues

In addition to theoretical concerns, a proper methodology has to be determined in order to provide suitable empirical evidence in support of the elaborated I/E model. Past studies normally examined the predictions of the original I/E model with structural equation modeling (SEM), e.g., Marsh and Hau (2004) or multiple regression, e.g., Williams and Montogmery (1995). On the other hand, the BFLPE was examined using the analysis of variance (ANOVA) (e.g., Manger & Eikeland, 1997; Rogers et al., 1978), path analysis (e.g., Marsh 1987), SEM (Marsh, 1994), or multilevel analysis (e.g., Marsh & Rowe, 1996). In addition, multilevel analysis appears to be a later development and an advanced technique, which has replaced ANOVA and path analysis, and become a typical way to examine the BFLPE. SEM is a powerful tool to model the structural relations between variables at one single level, especially at the individual level. Although SEM is gradually developing to include the analysis of multilevel data (du Toit & du Toit, 2001; Stapleton, 2002), the technique is still at a preliminary stage. Multilevel analysis can identify both the effects of individuals and groups at the same time, which address both the issues of internal and external comparisons. The present study therefore chooses multilevel analysis as the major statistical method to examine the extended I/E model posited here.

In summary, the present study uses multilevel analysis to explore the possibility of incorporation of the BFLPE into the I/E model and poses three research questions:

1. Are predications of the original I/E model (e.g., Diagram A in Figure 1) supported when the BFLPE is incorporated?
2. Is a significant BFLPE detected in math and science?
3. Is the BFLPE significant at the country level?

Method

Data Source and Sample

The data analyzed in the present study were taken from the database of the TIMSS 2003 database, which were compiled by the International Association for the Evaluation of Educational Achievement (IEA, 2005). The sampling method of the TIMSS was a three-level structure: students (Level 1), classes (Level 2) and countries (Level 3). The TIMSS 2003 database included math and science achievement of Grade-8 students from 47 countries. While the 47 countries had the data of student math self-concept, there were only 28 countries with the data of student science self-concept. Among the 28 countries, Syrian Arab Republic was the only one without the data of

country math and science achievements and so further analysis did not include data from this country. Hence, the final sample was 139,174 students nested in 4,887 classes of the remaining 27 countries, which were Australia, Bahrain, Botswana, Chile, England, Egypt, Ghana, Hong Kong, Iran, Israel, Italy, Japan, Jordan, Korea, Malaysia, Morocco, New Zealand, Norway, Palestinian Nat'l Auth., Philippines, Saudi Arabia, Scotland, Singapore, South Africa, Taiwan, Tunisia, and the United States.

Indicators

The present study focused on student and country levels. The effects of class math and science achievements are not the present study focus but worth an exploration as supplementary analysis because there is a need to model the 3-level sampling structure of the TIMSS.

Country math achievement. The values of country math achievement were taken from the column 'Average Scale Score' at Exhibit 1.1 in the TIMES 2003 International Mathematics Report (Mullis, Martin, Gonzalez, & Chrostowski, 2004, p. 34). The mean (*M*) of the 27 countries' math achievement was 452.41 and *SE* was 17.87.

Country science achievement. The 27 values of country science achievement were taken from Exhibit 1.1 in the TIMSS 2003 International Science Report (Martin, Mullis, Gonzalez, & Chrostowski, 2004, p. 36) with *M* = 463.04 and *SE* = 16.95.

Student math achievement (TIMSS-variable bsmmat01): There were five sets of plausible values of student math achievement provided by the TIMSS database. These values each were good estimates of the achievement of the student populations. The present study used the first plausible value (*M* = 450.38, *SE* = .33).

Student science achievement (TIMSS-variable bsssci01): There were also five sets of plausible values of student science achievement. The first plausible value was used (*M* = 457.94, *SE* = .34).

Student math self-concept (TIMSS derived-variable bsdmscl, termed 'self-confidence in learning math' in IEA (2005)). The scores were computed based on students' responses to four items on a 4-point Likert scale (from *1 = agree a lot* to *4 = disagree a lot*). The four items were '*I usually do well in math,' 'Math is more difficult for me than for many of my classmates (reversed),' 'Math is not one of my strengths,'* and *'I learn things quickly in math.*' The means of students' responses to the four items were calculated and categorized to: 1 = high (mean $\leqq$ 2), 2 = medium ($2 <$ mean < 3), and 3 = low (mean $\geqq$ 3). The categories were reverse-coded in the present study so that the larger numbers represented more positive self-concepts and vice versa (i.e., 3 = positive self-concept; 2 = medium; 1 = negative) (*M* = 2.20, *SE* = .00).

Student science self-concept (TIMSS derived-variable bsdsscl, termed 'self-confidence in learning science' in IEA (2005)). The scores were derived from students' responses to four items '*I usually do well in science,' 'Science is more difficult for me than for many of my classmates (reversed),' 'Science is not one of my strengths,'* and *'I learn things quickly in science.*' The methods of scaling, coding and scoring for student science self-concept were the same as those for student math self-concept. Also, a larger number of the value represented a more positive self-concept and vice versa (*M* = 2.35, *SE* = .00).

All the values of the above six indicators were transformed into standardized z scores (*M* = 0, *Standard Deviation* = 1). This procedure can facilitate the presentation and interpretation for the results from multilevel analysis and reduce the potential problem of multicollinearity, without at the expense of reliable and valid estimation of parameters. The procedure was especially necessary for the present data as the indicators were quite different in their score ranges, e.g., '1 – 3' (for

student self-concept) vs. ’264 – 605’ (for country math achievement). A similar procedure was successfully used by Marsh et al. (2000, 2007) and some studies reported in Raudenbush and Bryk (2002). With the procedure, the effect estimates presented in Tables 1-4 here can be explained as similar to standardized regression weights in traditional regression analyses.

Class math achievement was the average math achievement (z scores) of students within a class. *Class science achievement* was the average science achievement (z scores) of students within a class. These two sets of data were not re-standardized.

Statistical Analysis

Multilevel analysis was the major statistical method used to analyze the data. Before the analysis, however, we had to solve the problem of missing data. The proportions of missing data were 3.4% for math self-concept and 2.9% for science self-concept. There were no missing data for the other indicators. To deal with missing data, the procedure of multiple imputation (Olinsky, Chen, & Harlow, 2003; Schafer, 1997) was implemented using the software of LISREL 8.72 (du Toit & du Toit, 2001; Jöreskog & Sörbom, 2001, 2005). A new data set was generated by the procedure of multiple imputation using the data of the four indicators at the student levels and the other ten auxiliary variables taken from the same TIMSS database. The new data set remained the same as the original one except for the estimated values that replaced the missing data.

A series of three-level *multilevel analyses* was performed to explore the predicting utility of the indicators using the software of HLM 6.02 (Raudenbush, Bryk, & Congdon, 2005). The multilevel analysis was suitable for the present purpose because the students were nested within classes that were grouped into countries. Typical linear regression analysis can only deal with data from one single level, e.g., either the student level or the country level; if we aggregate data of heterogeneous levels to either level, the variance estimates will be biased. Multilevel analysis can separate variances contributed from different levels of data and take into account different sample sizes in each classes and countries. Multilevel analysis therefore can generate more unbiased estimates of fixed effects and standard errors than typical linear regression analysis. Detailed procedures for multilevel analysis can be found in literature such as Raudenbush and Bryk (2002), Raudenbush, Bryk, Cheong, Congdon, and du Toit (2004), and Snijders and Bosker (1999).

Results and Discussion

The present investigation explores the posited I/E model with the BFLPE based on a series of multilevel analysis, a statistical method that takes into account variances from students, classes and countries, which appropriately meets the structure of 3-level sampling of TIMSS. This investigation generates three major findings: (1) The predictions of the original I/E model is fully supported even if the BFLPE is incorporated for consideration. (2) The BFLPE is significantly detected in math, but not completely detected in science. (3) The BFLPE is significant at the country level, but not at the class level. Finally, reciprocal relations between achievement and self-concept are discussed.

A solid I/E model with a BFLPE

The predictions of the original I/E model are fully supported even when the effect of country math achievements (BFLPE) are taken into accounted. The result implies that the I/E model is a very

solid model and a robust theory, which is not changed when relevant and significant variables are included into the original model, or when country achievements are controlled. On the other hand, the result also suggests that the original I/E model may be an entire outcome of the process of *internal comparison* and there may be a need to incorporate the BFLPE (the process of pure *external comparison*) into the I/E model, which can significantly reduce unexplained variance from the country level. To describe in more detail, the I/E model will be elaborated when the group effect is actually taken into account together with the student effects. As a result, the combined country and student models could reduce large residual variance from the country level.

A stable, significant BFLPE in math, but not in science

The BFLPE has been evidenced in the school subject of math by past studies and so has the present study, but it is not stably supported in science. This may provide insight for BFLPE researchers to take account of a psychological process of domain-of-knowledge comparison.

Math appears to be a typical subject wherein the BFLPE occurs even controlling for the effect of science achievement and other factors. Furthermore, country math achievement not only has a negative effect on student math self-concept but also on student science self-concept. The reasons may be that (1) Math is one of the major bases of science; (2) It is more likely in math that students attribute their low achievement to low ability, an internal and stable factor by externally comparing with others, which is regarded a dysfunctional attribution (Weiner, 1985) because 'math is for smart people,' than that in science. For educational practice, teachers may need to decrease students' disposition towards competition in math learning by providing students with reflected-glory (Marsh et al., 2000), interdependent self-construal (Cheng & Lam, 2007) and favorable comparison (Burleson, Leach, & Harrington, 2005), which are related to accomplishments and social support of group mates (Abrami, Chambers, d'Apollonia, Farrell, & de Simone, 1992; Bane, Haymaker, & Zinchuk, 2005). Furthermore, these are teaching practices that may attenuate the BFLPE in not only math but also science (cf. Lüdtke, Köller, & Marsh, 2005; Marsh, Hau, & Craven, 2004).

Reciprocal relation between achievement and self-concept

There is similarity between models of student math and science achievement as dependent variables in their patterns of predicting utility. The two country and three student predictors each can positively predict the dependent variable. When controlling for some other more relevant predictors, the predicting effect of less relevant predictors reduced to non-significant or negative. In general, domain- and construct-specific effects dominate. There appears a slight difference in the trends of reducing predicting utility between self-concept and achievement as the dependent variables at the student-level: (1) Self-concepts as dependent variables: The less irrelevant achievement reduced to non-significant first and then to negative. (2) Achievements as dependent variable: The less irrelevant self-concept remained significant first and then reduced to non-significant. The results suggest that achievement is more differentiated than self-concept in their predicting utility. The I/E model predicts domain-specific positive paths and cross-domain negative paths from achievement to self-concept (Marsh et al., 2001, 2004). There may be a slower trend for the cross-domain paths from self-concept to achievement. We need a dataset with a number of different domains of achievement and self-concept data to explore this issue further.

The present study used one single wave of data to examine the likely 'causal' relationship between math/science self-concept and achievement, but only results based on analysis of a number of waves of data can be better used to make a claim of causal relationships (cf. Guay, Marsh, & Boivin, 2003; Marsh et al., 2000; Marsh, Hau, & Kong, 2002; Trautwein, 2007). While only results obtained by experimental methods can be utilized to make a claim of cause and effect, experimental methods for studying affective issues may be relatively un-ethical for young students.

Conclusion

An extended I/E model to the BFLPE in a comparison of math and science is evidenced a stable framework. The result supports the predictions of the original I/E model and the BFLPE and dictates possible multiple sources of academic self-concepts: A mixed regulation between internal and external comparison (cf. Dai, 2004) with a likely comparison between domains of knowledge. An accurate theory of interaction between achievement and self-concept is always of paramount importance for educational researchers, teachers, and students. What students need is not an un-realistic 'high confidence' but a structure of sound and accurate multidimensional academic self-concepts obtained by detailed psychological processes of internal, external, and domain-of-knowledge comparison with multiple frames of reference (Skaalvik & Skaalvik, 2002) in order to make sound career decision and maximize achievement.

References

Abrami, P. C., Chambers, B., D'Apollonia, S., Farrell, M., & De Simone, C. (1992). Group outcome: The relationship between group learning outcome, attributional style, academic achievement, and self-concept. *Contemporary Educational Psychology, 17,* 201-210.

Aiken, L. S., & West, S. G. (1991). Multiple regression: Testing and interpreting interactions. Newbury Park, CA: Sage.

Bane, C. M. H., Haymaker, C. M. B., & Zinchuk, J. (2005). Social support as a moderator of the big-fish-in-a-little-pond effect in online self-help support groups. *Journal of Applied Biobehavioral Research, 10,* 239-261.

Bong, M. (1998). Tests of the internal/external frames of reference model with subject-specific academic self-efficacy and frame-specific academic self-concepts. *Journal of Educational Psychology, 90,* 102-110.

Burleson, K., Leach, C. W., & Harrington, D. M. (2005). Upward social comparison and self-concept: Inspiration and inferiority among art students in an advanced program. *British Journal of Social Psychology, 44,* 109-123.

Burton, L. (1994). *Children learning mathematics: Patterns and relationships*. Hemel Hempstead: Simon & Schuster Education.

Cheng, R. W. Y., & Lam, S. F. (2007). Self-construal and social comparison effects. *British Journal of Educational Psychology, 77,* 197-211.

Chiu, M. S. (2007). Mathematics as mother/basis of science in affect: Analysis of TIMSS 2003 data. In J. H. Woo, H. C. Lew, K. S. Park, & D. Y. Seo (Eds.), *Proceedings of the 31st Conference of the International Group for the Psychology of Mathematics Education, 2,* 145-152. Seoul: PME.

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

Chiu, M. S. (in press). Approaches to the teaching of creative and non-creative mathematical problems. *International Journal of Science and Mathematics Education.*

Conger, A. J. (1974). A revised definition for suppressor variables: A guide to their identification and interpretation. *Educational and Psychological Measurement, 34*, 35-46.

Dai, D. Y. (2004). How universal is the big-fish-little-pond effect? *American Psychologist, 59*, 267-268.

Du Toit, M., & Du Toit, S. H. C. (2001). *Interactive LISREL: User's Guide*. Lincolnwood, IL: Scientific Software International, Inc.

Goetz, T., Frenzel, A. C., Hall, N. C., & Pekrun, R. (2008). Antecedents of academic emotions: Testing the internal/external frame of reference model for academic enjoyment. *Contemporary Educational Psychology, 33*, 9-33.

Goldstein, H. (1995). Multilevel statistical models (2nd ed.). London: Edward Arnold.

Gonzalez, E. J., Galia, J., Arora, A., Erberber, E., & Diaconu, D. (2004). Reporting student achievement in mathematics and science. In M. O. Martin, I. V. S. Mullis, & S. J. Chrostowski (Eds.), *TIMSS 2003 technical report* (pp. 275-307). Chestnut Hill, MA: TIMSS & PIRLS International Study Centre.

Guay, F., Marsh, H. W., & Boivin, M. (2003). Academic self-concept and academic achievement: Developmental perspectives on their causal ordering. *Journal of Educational Psychology, 95*, 124-136.

Hair, J. F., Jr., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2006). *Multivariate data analysis* (6th ed.). Upper Saddle River, NJ: Prentice-Hall.

Hox, J. (2002). *Multilevel analysis: Techniques and application*. Mahwah, NJ: Lawrence Erlbaum.

International Association for the Evaluation of Educational Achievement. (2005). *TIMSS 2003 user guide for the international database*. Chestnut Hill, MA: TIMSS & PIRLS International Study Centre.

Jöreskog, K. G., & Sörbom, D. (2001). *LISREL 8: User's reference guide.* Lincolnwood, IL: Scientific Software International.

Jöreskog, K. G., & Sörbom, D. (2005). LISREL (Version 8.72) [Computer software]. Lincolnwood, IL: Scientific Software International.

Kreft, I., & De Leeuw, J. (1998). *Introducing multilevel modeling*. London: Sage.

Leung, F. K. S. (2002). Behind the high achievement of East Asian students. *Educational Research and Evaluation, 8*, 87-108.

Liu, W. C., Wang, C. K. J., & Parkins, E. J. (2005). A longitudinal study of students' academic self-concept in a streamed setting: The Singapore context. *British Journal of Educational Psychology, 75*, 567-586.

Maassen, G. H., & Bakker, A. B. (2001). Suppressor variables in path models: Definitions and interpretations. *Sociological Methods & Research, 30,* 241-270.

Manger, T., & Eikeland, O. J. (1997). The effect of social comparison on mathematics self-concept. *Scandinavian Journal of Psychology, 38,* 237-241.

Marsh, H. W. (1984). Self-concept: The application of a frame of reference model to explain paradoxical results. *Australian Journal of Education, 28,* 165-181.

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

Marsh, H. W. (1987). The big-fish-little-pond effect on academic self-concept. *Journal of Educational Psychology, 79*, 280-295.

Marsh, H. W. (1989). Sex differences in the development of verbal and mathematics constructs: The High School and Beyond study. *American Educational Research Journal, 26*, 191-225.

Marsh, H. W. (1994). Using the national longitudinal study of 1988 to evaluate theoretical models of self-concept: The Self-Description Questionnaire. *Journal of Educational Psychology, 86*, 439-456.

Marsh, H. W. (2004). Negative effects of school-average achievement on academic self-concept: A comparison of the big-fish-little-pond effect across Australian states and territories. *Australian Journal of Education, 48*, 5-26.

Marsh, H. W., & Hattie, J. (1996). Theoretical perspectives on the structure of self-concept. In B. A. Bracken (Ed.), *Handbook of self-concept* (pp. 38-90). New York: Wiley.

Marsh, H. W., & Hau, K. T. (2003). Big-fish-little-pond effect on academic self-concept: A cross-cultural (26-country) test of the negative effects of academically selective schools. *American Psychologist, 58*, 364–376.

Marsh, H. W., & Hau, K. T. (2004). Explaining paradoxical relations between academic self-concepts and achievements: Cross-cultural generalizability of the internal/external frame of reference predictions across 26 countries. *Journal of Educational Psychology, 96*, 56-67.

Marsh, H. W., & Parker, J. W. (1984). Determinants of student self-concept: Is it better to be a relatively large fish in a small pond even if you don't learn to swim as well? *Journal of Personality and Social Psychology, 47*, 213-231.

Marsh, H. W., & Rowe, K. J. (1996). The negative effects of school-average ability on academic self-concept: An application of multilevel modeling. *Australian Journal of Education, 40*, 65-87.

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

Marsh, H. W., Chessor, D., Craven, R., & Roche, L. (1995). The effects of gifted and talented programs on academic self-concept: The big fish strikes again. *American Educational Research Journal, 32*, 285-319.

Marsh, H. W., Craven, R. G., & McInerney, D. M. (Eds.). (2003). *International advances in self research*. Greenwich, CT: Information Age.

Marsh, H. W., Craven, R., & Debus, R. (1999). Separation of competency and affect components of multiple dimensions of academic self-concept: A developmental perspective. *Merrill-Palmer Quarterly, 45*, 567-601.

Marsh, H. W., Dowson, M., Pietsch, J., & Walker, R. (2004). Why multicollinearity matters: A re-examination of relations between self-efficacy, self-concept, and achievement. *Journal of Educational Psychology, 96*, 518-522.

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

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

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

Marsh, H. W., Köller, O., & Baumert, J. (2001). Reunification of East and West German school systems: Longitudinal multilevel modeling study of the big-fish-little-pond effect on academic self-concept. *American Educational Research Journal, 38,* 321-350.

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

Martin, M. O., Mullis, I. V. S., Gonzalez, E. J., & Chrostowski, S. J. (2004). *TIMSS 2003 international science report*. Chestnut Hill, MA: TIMSS & PIRLS International Study Centre.

McFarland, C., & Buehler, R. (1995). Collective self-esteem as a moderator of the frog-pond effect in reactions to performance feedback. *Journal of Personality and Social Psychology, 68,* 1055-1070.

Mullis, I. V. S., Martin, M. O., Gonzalez, E. J., & Chrostowski, S. J. (2004). *TIMSS 2003 international mathematics report*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center.

Möller, J., & Köller, O. (2001). Dimensional comparisons: An experimental approach to the internal/external frame of reference model. *Journal of Educational Psychology, 93,* 826-835.

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

Olinsky, A., Chen, S., & Harlow, L. (2003). The comparative efficacy of imputation methods for missing data in structural equation modeling. *European Journal of Operational Research, 151,* 53-79.

Plucker, J. A., & Stocking, V. B. (2001). Looking outside and inside: Self-concept development of gifted adolescents. *Exceptional Children, 67,* 535-548.

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods*. Thousand Oaks, CA: Sage.

Raudenbush, S., Bryk, A., Cheong, Y. F., Congdon, R., & Du Toit, M. (2004). *HLM 6: Hierarchical linear and nonlinear modeling*. Lincolnwood, IL: Scientific Software International.

Raudenbush, S., Bryk, A., & Congdon, R. (2005). HLM for Windows (Version 6.02a) [Computer software]. Lincolnwood, IL: Scientific Software International.

Reise, S. P., & Duan, N. (2003). Design issues in multilevel studies. In S. P. Reise & N. Duan (Eds.), *Multilevel modeling: Methodological advances, issues, and application* (pp. 285-298). Mahwah, NJ: Lawrence Erlbaum.

Rogers, C. M., Smith, M. D., & Coleman, J. M. (1978). Social comparison in the classroom: The relationship between academic achievement and self-concept. *Journal of Educational Psychology, 70,* 50-57.

Schafer, J. L. (1997). *Analysis of incomplete multivariate data*. London: Chapman & Hall.

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

Skaalvik, E. M., & Rankin, R. J. (1992). Math and verbal achievement and self-concepts: Testing the internal/external frame of reference model. *The Journal of Early Adolescence, 12,* 267-279.

Skaalvik, E. M., & Rankin, R. J. (1995). A test of the internal/external frame of reference model at different levels of math and verbal self-perception. *American Educational Research Journal, 32*, 161-184.

Skaalvik, E. M., & Skaalvik, S. (2002). Internal and external frames of reference for academic self-concept. *Educational Psychologist, 37*, 233-244.

Snijders, T. A. B., & Bosker, R. J. (1999). *Multilevel analysis: An introduction to basic and advanced multilevel modeling*. Thousand Oaks, CA: Sage.

Stapleton, L. M. (2002). The incorporation of sample weights into multilevel structural equation models. *Structural Equation Modeling, 9*, 475-502.

Tymms, P. (2001). A test of the big fish in a little pond hypothesis: An investigation into the feelings of seven-year-old pupils in school. *School Effectiveness and School Improvement, 12*, 161-181.

Wigfield, A., & Eccles, J. S. (2000). Expectancy-value theory of achievement motivation. *Contemporary Educational Psychology, 25*, 68-81.

Wilkins, J. L. M. (2004). Mathematics and science self-concept: An international investigation. *The Journal of Experimental Education, 72*, 331-346.

Williams, J. E., & Montogmery, D. (1995). Using frame of reference theory to understand the self-concept of academically able students. *Journal for the Education of the Gifted, 18*, 400-409.

Wong, M. S. W., & Watkins, D. (2001). Self-esteem and ability grouping: A Hong Kong investigation of the big fish little pond effect. *Educational Psychology, 21*, 79-87.

Yeung, A. S., & Lee, F. L. (1999). Self-concept of high school students in China: Confirmatory factor analysis of longitudinal data. *Educational and Psychological Measurement, 59*, 431-450.

Zeidner, M., & Schleyer, E. J. (1999). The big-fish-little-pond effect for academic self-concept, test anxiety, and school grades in gifted children. *Contemporary Educational Psychology, 24*, 305-329.

Zimmerman, B. J. (1995). Self-efficacy and educational development. In A. Bandura (Ed.), *Self-Efficacy in changing societies* (pp. 202-231). Cambridge: Cambridge University Press.

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

國科會補助專題研究計畫項下出席國際學術會議心得報告

日期： 101 年 9 月 14 日

計畫編號	NSC 100-2511-S-004-004		
計畫名稱	臺灣數理教學與學習之文化藝品、信念、知識與策略發展：與 PISA 和 TIMSS 結果的關係		
出國人員 姓名	邱美秀	服務機構 及職稱	國立政治大學教育學系 教授
會議時間	2012 年 8 月 22-24 日	會議地點	Antwerp University, Antwerp, Belgium (比利時)
會議名稱	(中文) 「歐洲學習與教學研究學會」第 14 組「學習與專業發展」2012 年會 (英文) *European Association of Research in Learning and Instruction (EARLI) Special Interest Group 14 "Learning and Professional Development" 2012 Conference*		
發表論文 題目	(中文) 文化藝品對教師專業學習的影響:以臺灣高中數學教師為例 (英文) Roles of cultural artifacts in teacher professional learning: The case of high-school mathematics teachers in Taiwan		

一、參加會議經過

22 日註冊與參加會議安排的學術活動

23 日發表論文與參加會議安排的學術活動

24 日參加會議安排的學術活動

二、與會心得

1、「歐洲學習與教學研究學會」的第 14 組為「學習與專業發展」，這次的會議的主題是「learning in transition」。參與論文發表的學者人數約 140 位，大多來自歐洲各國，少部分來自其他洲，來自亞洲的有新加坡和臺灣(也就是此篇論文發表)。研究主題大多在各領域專業人士(例如醫學、工業、教師)的專業發展，也兼顧學校學生從生手到專家的學習歷程，重視學校教育與職場工作連結的教育。質性與量化研究兼具，也有 eye movement 的實驗研究，主要探討醫生或醫學系生的視覺診斷(例如 x 光片)的差異，並且由實驗結果設計可能的有效教育醫學系生的教學模式。

2、審查論文給的建議很具體(例如提供很具體的 references)，有助學者增進論文發表的品質，論文水準頗高。

3、此次發表的這篇論文，重臺灣文化對教師專業工作的影響，歐洲學者普遍覺

得很有趣，也分享他們各國的經驗與在亞洲的經驗，也提供後續研究建議，收穫良多。

4、本來以為這個組應該是學者在自己的或某個領域內談「某個領域的專業發展與學習」，應該比較重領域內不同學習階段、或是從學校到職場間的學習發展。可是參加此會議的各場次 keynote speeches 和論文發表會後，發現這個分組的學者很喜歡「跨界」(cross boundaries)的研究，他們在介紹學者與評論各研究論文時，隱約間均讚賞「跨界的研究」，跨知識領域學科、跨理論與實務、跨學習階段、跨學校與職場、跨國界…等。學者們自身進行跨界研究，也真實的反省自身跨界的困難，並力圖使「跨界學習」的過程更為順暢，也許真正的專業學習本身就是不斷的「跨界」。

5、交替的會議安排

(1)大會與分組會議交替：「歐洲學習與教學研究學會」以每二年一輪的方式，一年辦整體的大會，隔年辦各組的會議。這個設計很不錯，整體大會時(千人以上)，可以了解各研究領域的全貌；分組會議時，人數較少(百人左右)，因為所有與會者的興趣和研究領域更近似，三天內幾乎每天都可看到所有與會者，可和與會者進行很深入的討論，因此，也就更易談共同研究的可能性。

(2)全組與小型討論會交替：每日均有全組的 keynote speech 與小型論文發表討論會，可全體見面，又可深入進行小組論文。

(3)正式會議與非正式社交活動交替：白天是正式會議，coffee break 和 lunch 均是大家一起在一個不大但又剛好夠大的地方取食物，大多數人都圍著數個小桌子(以便放食物)站著吃，旁邊有階梯可坐(但就沒有桌子)，這樣的設計，很奇妙，讓大家於每場會議後，還會聚在一起繼續討論會議內容。會議的前、後、晚上則安排有非正式的社交活動，例如：city center 導覽、city hall 參觀導覽、聚餐、結束時的小 party，整體會議氣氛是知性與友誼的結合。

三、發表論文全文或摘要

Abstract (300 words max.)

The aim of this study is to identify significant cultural artifacts that play roles in mathematics teachers' professional learning. Five high-school mathematics teachers from Taiwan are interviewed individually using semi-structured guiding questions. Qualitative data analysis are used to identify significant cultural artifacts, clarify the constraints and affordances of the artifacts, and investigate teachers' emotional responses, strategy use, and work identities in response to the artifacts. The analysis identifies five significant artifacts. (1) The national curriculum designed by college experts shapes the order of the unchanging mathematics contents and invites student-centred teaching. (2) Mathematical problems offer diverse affordances, which

are subject to two major teacher beliefs: problem- or concept-based teaching. (3) The competitive and unified college entrance examination system directs student efforts and teacher teaching. (4) Cram schools are popular among students, which push the teachers to play a supplement role in mathematics teaching. (5) Information communication technology (ICT) is promising but still in a trial-and-error stage for teaching, and only the ICT professionally trained teacher aims to overcome the difficulties and take ICT as a major tool supporting teaching. The major theme underlying the use of these artifacts is teacher beliefs of effective teaching, student characteristics, and time changes. **Acknowledgements:** This research was supported by the National Science Council, Taiwan (NSC 100-2511-S-004 -004).

Extended summary (1000 words max.)

Aims. The aim of this study is to identify significant cultural artifacts that play roles in the teaching of high-school mathematics teachers, clarify the constraints and affordances of the artifacts, and investigate teacher responses to these artifacts.

Literature Review. Artifacts in mathematics teaching reflect the innate beliefs, knowledge, strategies, and creativities of a culture and teachers. The mathematics curriculum in Taiwan formally introduced student-centred constructivism for primary and junior-high school students in 1993 (Ministry of Education in Taiwan, 1993). The new senior-high school mathematics curriculum formally launched in 2010 (Ministry of Education in Taiwan, 2011b), also following a student-centred approach. In response to the student-centred curriculum, more creative problems are included in the textbooks in Taiwan. Chiu's (2009) study finds that problems used as presented by textbooks and spontaneously created by teachers in mathematics classrooms can best represent teachers' teaching approaches. Tsai's (2001) study shows that Taiwan's national curriculum has a heavy content load, along with regular cross-class standard tests, which may hinder teachers' implementation of Science-Technology-Society instruction. Teaching approaches may also relate to after-school teaching by parents and cram-school teachers, and student responses to learning mathematics (Chiu & Whitebread, 2011; Whitebread & Chiu, 2004).

Research Questions. The above review of literature suggests that cultural artifacts may play an important role in teacher professional learning. This study, therefore, aims to answer the following three research questions. (1) What are the significant cultural artifacts that play roles in teacher professional learning? (2) What are the constraints and affordances of the cultural artifacts? (3) How do teachers respond to the cultural artifacts?

Methodology. The major research method of this study is interview, followed by qualitative data analysis.

Participants. The research participants were six mathematics teachers (two females and four males) from four senior-high schools in Taiwan.

Data Collection. The participants were interviewed individually. All the interviews were fully audio-recorded. The mathematics teachers were interviewed with the following guiding questions. (1) What are your perceptions, concerns, and teaching methods for the curricula over time? (2) What are the changes in your teaching strategies in both the psychological and physical aspects (e.g., teaching methods, materials, tools) along the time/curriculum development? (3) What are your major concerns about the changes? (4) What are the best methods to teach mathematics?

Data Analysis. The interviews were fully transcribed into verbatim transcriptions and analyzed using qualitative data analysis methods (Charmaz, 2000; Marton, 1981; Miles & Huberman, 1994; Strauss & Corbin, 1990, 1998).

Findings. The data analysis identifies five significant cultural artifacts. The major theme underlying the use of the artifacts is teacher beliefs.

National Curriculum. The national curriculum designed by college experts shapes the order of the unchanging mathematics contents and invites student-centred teaching. The teachers conform and adapt to the national curriculum. The conformation and adaptation, however, are not based on their belief that the designs or the changes in the national curriculum are correct or good, but based on their belief that the national curriculum are designed by authorities, who are able at the domain of knowledge and offer little space for arguments.

Mathematical Problems. Mathematics problems offer diverse affordances. Two major approaches, problem-based (bottom-up) and concept-based (top-down) ones, are used by the teachers in the use of diverse kinds of problems.

College Entrance Examination. The competitive and unified college entrance system directs student efforts and teacher teaching. Mathematics is a common school subjects for all students. The examination and school systems, however, include only two categories of contents: mathematics for students aiming to study humanities and social sciences, and that for students aiming to study natural sciences in college. This system appears to fail to reflect and adapt to diverse student characteristics. Teachers face dilemma between teaching practical or academic mathematics.

Cram School. Most students go to cram schools after school. The only aim of cram school teaching is to help students obtain high scores in examinations. The school teachers have no choice but to play a supplement role in mathematics teaching.

Information Communication Technology (ICT). ICT is promising but still in a trial-and-error stage for teaching. Among the five teachers, only one teacher with an

academic degree in ICT aims to overcome all the difficulties and uses ICT as a major tool in supporting teaching. He believes logics and concepts are the most important in mathematics learning and ICT is a new trend that can help fulfill the belief. After failure in several trials of advanced ICT use, he decides to invest all his class teaching in traditional ways of ICT use (e.g., PowerPoint and GeoGebra), by which he transmits basic mathematics concepts in a concrete format. All practices of mathematical problem-solving become homework.

Theoretical and Educational Significance of the Research. The above findings give birth to a picture of teacher professional learning with the five artifacts as the major roles. The first four artifacts may be placed in the centre of the picture. The national curriculum serves as a weak leader and the college examination system a strong leader, which lead to the diverse use of mathematical problems in formal and cram schools. The cram schools play the game of the examination system well. The teachers have little choice but to play a supplement role in examination preparation. ICT places itself in the status of peripheral participation in the picture (to use Lave and Wenger's (1991) term) although ICT use in teaching is highly advocated by the government, scholars, and industries in Taiwan.

Persistent ICT use appears to be highly related to teacher beliefs in the effectiveness of ICT in promoting student learning, and professional abilities of ICT. As indicated by Chai, Hong, and Teo (2009), teacher ICT use is related to traditional teaching approaches in Taiwan. This study finds that even the simple integration of ICT use and traditional teaching may make teachers with both mathematics and ICT degrees take much time and effort to undergo a trail-and-error process. Other cultural artifacts, such as the strict examination system, may be a social barrier against the advanced use of ICT in teaching.

Keywords: cultural artifacts; ICT use; mathematics teaching; national curriculum; social culture

四、建議

1、「跨界」的議題與行動：「歐洲學習與教學研究學會」是國際上重要的教育「專業」社群，但此會議非常讚賞「跨界」。反觀目前學校系統傾向發展越來越細的部門，分學門、分學科、分系、分研究所、分組…等，但是，真正職場上的專業發展與競爭力的展現，卻可能來自不斷的「跨界」學習，而能持續突破、創新與卓越。「跨界」是好的、正當的、常態的？大家對「跨界」的接受度如何？「專業」與「跨界」如何共存、互利、共生？跨界的難度，應該是存在的，這個難度，可能來自個人、也可能來自社會，這可能需要個人與社會整體的制度與心理發展才能達成。

2、建立更彈性、寬廣、友善的跨國、跨領域研究平台：因「歐洲學習與教學研究學會」分組會議的人數較少(百人左右)，並且會議設計讓與會者可進行深入的討論與情誼的建立，故，有利於合作研究。例如：此次，與一位歐洲的醫生相談甚歡，因他的研究主題較近「科學(醫學)教育」且近「情意」，故能有較深入的互動，並談到未來是否可再一起參加會議、一起討論或做研究。也許，更彈性、更多元的跨領域研究平台或資訊的建立，是一個議題。

3、安排有利互動的會議情境：如在心得處所描述的「全組與小型討論會交替」、「正式會議與非正式社交活動交替」似乎能營造一個有利學者互動的情境，可參考之。

五、攜回資料名稱及內容

1、會議議程(含所有論文的摘要)。

2、所有與會者的名單與連絡 email。

六、其他：論文被接受發表之大會證明文件

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YOUR REF
OUR REF
EARLI SIG 14 conference
DATE
22 August 2012
ENCLOSURE

Dear Mrs Chiu

I hereby confirm your attendance at the EARLI SIG 14 conference 2012. The event took place at the University of Antwerp, Belgium, from 22 until 24 August 2012. The registration fee ([redacted]) was paid by [redacted].

The theme of the conference was *'Learning in Transition'*. Your presentation entitled *"Roles of Cultural Artifacts in Teacher Professional Learning: the Case of High-School Mathematics Teachers in Taiwan"* was included in Paper Session 13 which was organized on Thursday August 23rd 2012, from 15.30h until 17.00h.

More information can be found on the conference website: www.ua.ac.be/earlisig14.

I thank you for your co-operation and I look forward to meeting you again!

Kind regards,
Ann Aerts

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會議 Website: www.ua.ac.be/earlisig14

國科會補助計畫衍生研發成果推廣資料表

日期:2012/09/13

國科會補助計畫	計畫名稱: 台灣數理教學與學習之文化藝品、信念、知識與策略發展：與PISA和TIMSS結果的關係
	計畫主持人: 邱美秀
	計畫編號: 100-2511-S-004-004- 學門領域: 數學教育

無研發成果推廣資料

100 年度專題研究計畫研究成果彙整表

計畫主持人：邱美秀	計畫編號：100-2511-S-004-004-
計畫名稱：台灣數理教學與學習之文化藝品、信念、知識與策略發展：與 PISA 和 TIMSS 結果的關係	

成果項目			量化			單位	備註（質化說明：如數個計畫共同成果、成果列為該期刊之封面故事...等）
			實際已達成數（被接受或已發表）	預期總達成數(含實際已達成數)	本計畫實際貢獻百分比		
國內	論文著作	期刊論文	0	0	100%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	1	1	100%		Chiu, M.-S. (2011). Differences between preservice teachers experiencing traditional- and constructivist-mathematics-curriculum in Taiwan. Paper presented at the 2011 Taiwan Education Research Association International Conference on Education, National Sun Yat-sen University, Kaohsiung, Taiwan. December 15-18.
		專書	0	0	100%		
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（本國籍）	碩士生	2	2	100%	人次	
		博士生	0	0	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		
國外	論文著作	期刊論文	1	1	100%	篇	Chiu, M.-S. (2012). The internal/external frame of reference model, big-fish-little-pond effect, and combined model for mathematics and science. Journal of Educational Psychology, 104, 87-107. doi: 10.1037/a0025734
		研究報告/技術報告	0	0	100%		
		研討會論文	2	2	100%		Chiu, M.-S. (2012). Effects of cultural artefact use on student mathematics motivations, effort, and achievement. Paper presented at the 36th Conference of the International Group for the

							Psychology of Mathematics Education, Wesley Girls High School, Taipei, Taiwan, 18-22 July, 2012. Chiu, M.-S. (2012). Roles of cultural artefacts in teacher professional learning: The case of high-school mathematics teachers in Taiwan. Paper presented at the European Association of Research in Learning and Instruction (EARLI) Special Interest Group 14 'Learning and Professional Development' 2012 Conference, Antwerp University, Antwerp, Belgium, 22-24 August 2012.
		專書	0	0	100%	章/本	
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（外國籍）	碩士生	0	0	100%	人次	
		博士生	0	0	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		
其他成果(無法以量化表達之成果如辦理學術活動、獲得獎項、重要國際合作、研究成果國際影響力及其他協助產業技術發展之具體效益事項等，請以文字敘述填列。)		無					

科教處計畫加填項	成果項目	量化	名稱或內容性質簡述
	測驗工具(含質性與量性)	0	
	課程/模組	0	
	電腦及網路系統或工具	0	
	教材	0	
	舉辦之活動/競賽	0	
	研討會/工作坊	0	
	電子報、網站	0	

目	計畫成果推廣之參與（閱聽）人數	0	

國科會補助專題研究計畫成果報告自評表

請就研究內容與原計畫相符程度、達成預期目標情況、研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）、是否適合在學術期刊發表或申請專利、主要發現或其他有關價值等，作一綜合評估。

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估

■達成目標

□未達成目標（請說明，以 100 字為限）

□實驗失敗

□因故實驗中斷

□其他原因

說明：

2. 研究成果在學術期刊發表或申請專利等情形：

論文：■已發表 □未發表之文稿 □撰寫中 □無

專利：□已獲得 □申請中 ■無

技轉：□已技轉 □洽談中 ■無

其他：(以 100 字為限)

3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）(以 500 字為限)

Chiu, M.-S. (2012). The internal/external frame of reference model, big-fish-little-pond effect, and combined model for mathematics and science. Journal of Educational Psychology, 104, 87-107. doi: 10.1037/a0025734 (SSCI) (NSC-95-2522-S-004-001； NSC 100-2511-S-004 -004)對教育心理學有關成就與自信間關係的二大理論，提出批判，並提出新的理論模式，對數理跨領域間的關係進行跨國文化的比較;用多層次統計分析國際資料庫。此期刊的 impact factor 頗高(2011 年 ISI Impact Factor: 3.583，排名 Psychology - Educational: 2 of 50)，為教育心理界最具權威的期刊(之一)。此 paper 登出後，頗為教育界(尤其是教心界)國內外學者與學生肯定，因為，JEP 在教心界應該是頂極的期刊，此 paper 獨立在臺灣完成，可見，臺灣本地可產出世界級、國際化的作品，而能對世界知識有貢獻。