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A Culture-Bound Look on Mathematics Beliefs: Differences between China and U.S.A. Students[1]

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Abstract: Two-hundred and thirty Chinese students enrolled in grades 10 and 11 were surveyed to compare their mathematics beliefs with American students by using a questionnaire developed by Schoenfeld. The overall findings indicate that there are culture-based differences in the mathematics beliefs between the two countries. The findings show what the most salient different mathematics beliefs are and why these beliefs account for causal value-laden relationships between achievement and culture-bound factors. There exist underlying cultural traditions which propose a causal model of mathematics beliefs as a possible explanation of the performance differences which exist in students of the two countries.

Introduction

In recent years, student achievement comparisons have inspired numerous research endeavors from researchers in mathematics education (Rohlen, 1983; Stevenson & Stigler, 1992; Leung, 1995; Schmidt, et al., 1996; Stigler & Hiebert, 1999). One promising area of study has focused on the comparisons of students' achievement in from East Asian countries with the achievement in Western countries. The reason is that East Asian students have consistently outperformed their counterparts in Western countries in international studies of achievement (Wong, Marton, Wong, & Lam, (in press); Wong & Watkins, 2001). The explanation for this finding is complex and must be considered from various perspectives: for example, language differences can play an important role in mathematics learning, parents' high expectations for education, the diligence of the people, the school system with national curriculum, and good teachers. Entrance examinations and the importance of academic careers in society also should be taken into account. There are many predominant cultural factors. No single crucial factor can be found that explains this phenomenon. In general, it is an outcome resulting from a complicated mixture of various factors with complex, interlinked relationships. Some research executed in the last several years to explain these differences have focused on the role of cultural beliefs and values.

Several years ago, I (Sun) was inspired by Schoenfeld`s (1989) work, "Explorations of students` mathematics beliefs and behavior", published in the Journal for

[1]I wish to thank Alan H. Schoenfeld for his permission to use his questionnaire, and Professor Klaus D. Graf, Freie University Berlin for his comments and recommendations.

Research in Mathematics Education. This paper explored aspects of the relation between students` mathematics beliefs and their mathematical performance, and it examined how the ways of people's conceptions of mathematics shape the ways they engage in mathematical activities. I wondered if and how the data would change when the questionnaire was given to Chinese students. Notably missing from all TIMSS and PISA studies were students from China, whose education authorities chose not to participate in TIMSS and PISA.

After I actually collected data, it was so confusing that I could not explain it for five years. For example, the mean of self-evaluation of Chinese students was rather low. Dating back to the National Longitudinal Study of Mathematical Ability (Crosswhite, 1972), research studies have consistently showed positive correlations between confidence and achievement. I wondered why this principle was not true in general for all students. The achievement of Chinese students is higher, but they showed lower confidence at the same time. I did not consider that confidence is culture-bound and that comparisons should be based on the same factors until recently. As soon as I put all salient differences together with a culture–bound look, a clear casual model (to be discussed below) resulted from the complex data.

For this paper, we looked into the implicit set of values or rationale behind those factors with a culture-bound perspective. To elaborate, we explored the causal value-laden relationships between achievement and other culture-bound factors, and compared China with it's the Confucian tradition on one side and U.S.A with the Hellenistic and Christian tradition on the other side. By choosing to study these differences using these two "poles" of cultural traditions, with pertinent examples, it was hoped that this comparison may shed light on understanding the mathematics beliefs behind the education systems and how the systems operate under different education traditions and culture. The aims of this study include the following:

1. What are the most salient differences in mathematics beliefs?
2. Are these salient differences in mathematics beliefs related to value-laden and culture-bound factors or not?

Methodology

Sample

When comparing the mathematical beliefs of students in two countries, it is important to measure representative samples with the same type of grouping of students. But such comparison is impossible in other than a large-scale, government directed study. As an alternative, when selecting the Chinese participants we made approximations in sample size and grade level with those in the Schoenfeld study. The Chinese high-, average-, and low-achieving students (n=230) participated in the study when they were enrolled in high school in the same metropolitan area of

Guangzhou in China. Of the 230 students, 103 students were enrolled in 10th grade, 127 in 11th grade; 133 students were male and 97 were female. In view of the nature of the sampling, they are by no mean representative of all students from the two countries. The data of USA students from Schoenfeld`s study were published in 1989 and the data of Chinese were collected in 1998. All the results and findings are thus limited and are not generalizable to the wider population of students of the two countries.

Instrument

To find differences, we used the same questionnaire developed by Schoenfeld (1989), containing 70 multiple-choice questions with a 5-point Likert-type scale ranging from 1 (strongly agree) to 5 (strongly disagree). The questionnaire contains questions related to attributions of success or failure; motivation; the nature of mathematics, and personal and scholastic performance and motivation. For example, with the statement "when you get a good grade in mathematics it is because you work hard", students were asked to circle the number under the answer that best described what they think or feel. Minor modifications of the questionnaire were made to suit the needs of the Chinese respondents. Firstly, the questionnaire was translated into Putonghua, the official language and medium of instruction of China. The questionnaire was first translated by myself (Sun) and then validated by two postgraduate students with English language majors to ensure the translated copy was as equivalent as possible in content and meaning to the English version. The teachers administered the questionnaire to their pupils during normal class periods. In terms of the understanding of the questionnaire, no report of difficulties was received.

Findings and discussion

Some of the major findings of the study are highlighted and discussed below.

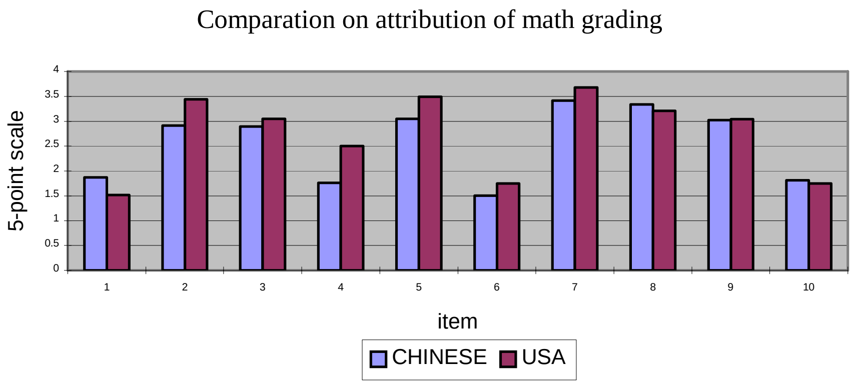
Attribution of success or failure

The responses to the ten questions on attribution in mathematics grading questions, reported for the Chinese and USA students, are given in table 1. The data were examined for differences using the standard error of a difference between uncorrelated means in our statistical analysis. In general, the students in the two countries attributed both mathematics academic success and failure to effort or work and interest, not good luck. Mathematics was regarded as an objective discipline: if they can not perform well, they considered it to be their own fault.

However, it is worth noting here that the Z values of items 1, 2, 4, 5, 6, 7 for differences on these questions exceed 1.96, $P<0.05$. It means that the attribution pattern in mathematics grading questions was significantly different in the two countries. The Chinese students tended to emphasize effort and interest more than Americans (see items 1, 4, and 6). Nevertheless, it was found that Chinese students emphasized the teachers' attitudes in grading more than Americans students. The findings strengthen the validity of previous research. (Huang, & Waxman, 1997), and concur with other cross-cultural studies (for example, Ryckman & Mizokawa, 1988). Namely, Eastern societies tend to highly value effort, perseverance and hard work, whereas Western counterparts tend to view mathematical ability and creativity as the more important contributing factors for success in mathematics.

Table 1
Means and standard deviations on attribution of mathematics grading (section 1 and section 2)

Item		Chinese students M (sd)	USA students M (sd)	Z
1	attribution to effort when good grade	1.871(0.956)	1.52(0.618)	4.098
2	attribution to teacher's attitude when good grade	2.911(0.981)	3.44 (0.720)	-6.578
3	attribution to luck when good grade	2.891 (1.019)	3.05 (0.854)	-1.804
4	attribution to interest when good grade	1.762(0.896)	2.50(.906)	-8.744
5	not know when good grade	3.05(1.152)	3.49(0.687)	4.952
6	attribution to effort when bad grade	1.505(0.743)	1.75(0.861)	-3.252
7	attribution to teacher's attitude when bad grade	3.416(0.852)	3.68(0.608)	-3.808
8	attribution to bad luck when bad grade	3.337(0.930)	3.21(0.834)	1.548
9	attribution to interest when bad grade	3.02(1.086)	3.04(0.902)	-0.219
10	attribution to carelessness when bad grade	1.812(0.880)	1.75(0.723)	0.821



These different results of mathematical attributions also indicate that there are significant differences in motivation of mathematics learning and different value conceptions. The different motivational style is characterized by perseverance and commitment. Mathematics actions are a kind of choice based on the mathematics value view. Every choice is made according to this value conception system which is made up of expectations, demands and standards, which are deeply embedded in the cultural environment. This value-conception system facilitates judgment and decisions: how to distribute its energy and effort on mathematics, how much and how long to study mathematics. These decisions are based on students' own self-goals, values of task and need-dispositions in the classroom and family.

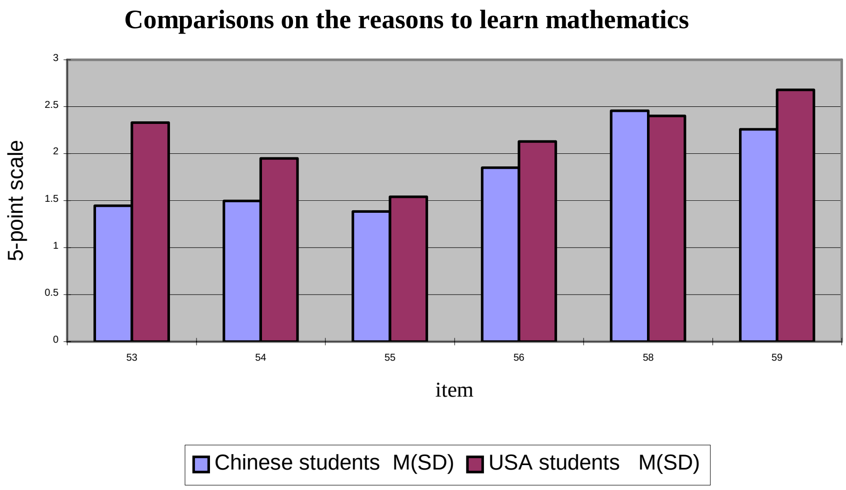
Reasons to learn mathematics

In general, mathematics is regarded as not only a required discipline to help think clearly, but also an interesting subject where students are eager to learn and demonstrate their cleverness in problem solving at the same time.

The data of item 53, in Table 2, also indicate that Chinese students firmly believe in mathematics curriculum values and might account for the slightly higher level of mathematics values in the attained curriculum. This may explain why the Chinese students' achievement in mathematics has been superior - "mathematics value recognition" influences one's behavior. Moreover, we can deduce that these different mathematics beliefs on epistemological aspects of the processes of learning mathematics, namely, the explicit values and appreciation of the importance of mathematics, are emphasized in Chinese mathematics beliefs. Because the value conception system facilitates judgments and decisions, the system helps students to determine how to distribute their energy and effort on mathematics and on how much and how long they should study math. Any decision is based on the value of task in their eyes.

Table 2
Means and standard deviations on reasons to learn mathematics (section 11)

Item		Chinese students M (SD)	USA students M (SD)	Z
53	mathematics helps to think clearly	1.446(0.728)	2.33(0.802)	-12.35
54	mathematics is a mandatory subject	1.495(0.795)	1.95(0.972)	-5.47
55	hope to do well	1.386(0.721)	1.54(0.652)	-2.39
56	it is interesting	1.851(0.963)	2.13(0.905)	-3.19
58	afraid to be laughed at	2.455(1.082)	2.400(0.944)	0.58
59	do not want to look dumb	2.257(1.163)	2.68(1.030)	-4.10



The responses to item 54 indicate that the Chinese students' reasons to learn mathematics differ significantly from the Americans ($p<0.01$). Mathematics is a more mandatory subject for the Chinese students; in fact, in China, mathematics is a prerequisite entry test discipline to university or college. This means the bar is always set higher, which may potentially remove their inertia from them.

Items 55 and 56 indicate that Chinese students have a stronger desire to learn and higher interest to do well in mathematics and hence we may deduce that the students would be concerned about the value of and their needs for mathematics. Thus students would focus their energy and effort on mathematics exercises and assignments much more than the Americans would. Moreover, the high desire and interest also help to make mathematics more accessible to the Chinese students, and to have much more chance to perform well.

Value view of their parents in students` eyes

The data from two items related to parents' views of mathematics, items 69 and 70, indicate that Chinese parents tend to stress the importance of mathematics much more than American parents in students' eyes. This kind of exposure to the importance of mathematics from their parents may indirectly influence students' school performance and make them strive for excellence. The data also imply they could get a higher level of support from parents. The level of support from parents is significantly related to mathematics performance (Cooper & Robinson, 1991).

In addition, this data also illustrate the interpretation on Chinese mathematics inculcation carried out in the family. In Chinese culture, society stresses family orientation and conformity among peoples by meeting parents' expectation and being obedient to parents' demand in the family or society (Meade & Barnard, 1973). Parents may be more involved in what their children are doing in mathematics than American parents.

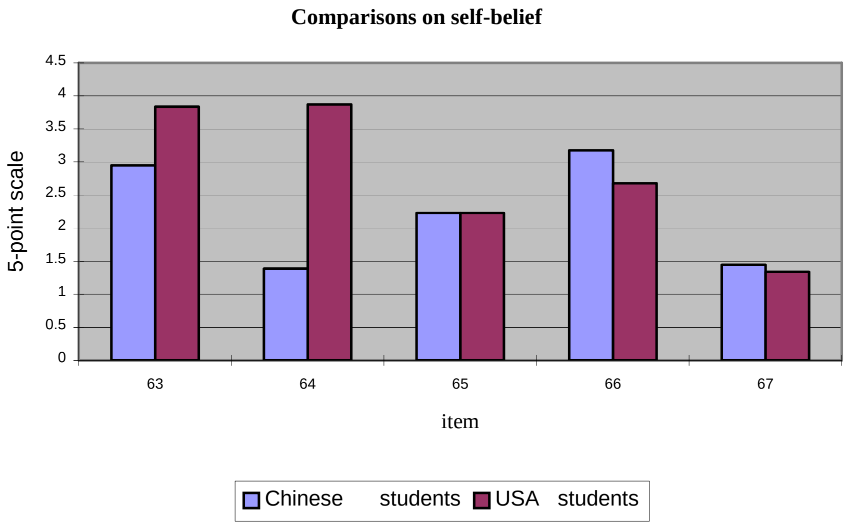
Self-belief

It is striking and particularly notable that the Z values of items 63, 64, and 66 for differences, in Table 3, exceed 2.58, $P<0.01$, which means that self-belief was significantly different in the two countries. The Chinese students tended to be lower in self-evaluation (see item 63 mean 2.950 as compared to 3.84). The data are consistent with the findings about American students as reported by Stevenson, Lee, and Stigler (1986). Chinese students are likely to place less credence in their native ability than their American counterparts do.

The Chinese students tended to be higher in self-expectation (see the striking item 64 mean 1.386 as compared to 3.87). The higher self-expectation maybe exerts significant influence on personal goal setting and other various aspects of self-regulation, such as monitoring of activity choices, working plan, effort, persistence. According to Siegel, Galassi, and Ware, (1985) each of the variables (skills, incentives, efficacy expectations, and outcome expectations) that underlie students' mathematics performance may account for significant and unique increments in performance variation.

Table 3
Means and standard deviations on Self-belief (section 12)

Item		Chinese students M (SD)	USA students M (SD)	Z
63	self-evaluation	2.950(0.779)	3.84(0.896)	11.2938
64	self-expectation	1.386(0.600)	3.87(0.989)	32.3523
65	self-evaluation on self-ability	2.227(0.691)	2.23(1.04)	0.03623
66	self-evaluation on the self-effort	3.178(1.014)	2.68(1.030)	5.1904
67	self-evaluation on the homework	1.446(0.591)	1.34(0.511)	2.0475



The data of item 66 (mean 3.178 as compared to 2.68) also indicate that Chinese students could attribute lower valuation to the self-effort. The higher outcome expectation and lower self-valuation may mean that the students could actually be monitoring their self-regulated mathematics learning progress by mediating and controlling their persistence, as well as other self-regulation factors.

Causal Model

Based on this data and our subsequent analysis, we suggest that there is a causal model of Chinese culture-bound mathematics beliefs and achievement. See Figure 1. The overall data highlight that mathematics beliefs are value-laden and culture-bound. In China where mathematics is an obligatory subject with a national curriculum, and is a discipline of entrance examination before students enter college, students are involved not only in a social environment different from USA but also in the family environment where their parents highly confirm the importance of mathematics and firmly support them with high expectations. Furthermore we imagine that they are influenced continuously in this environment which makes them form a motivation mechanism different from that of the USA. That is, the Chinese students may be more eager to learn mathematics even with their lower self-evaluation and higher self-expectation. This motivation mechanism controls self-regulation systems, which exerts significant influence on personal goal setting, as well as monitoring of planning, effort, and persistence.

As well as identifying what are the most salient of the different mathematics beliefs between the Chinese and American students our findings suggest these salient differences in mathematics beliefs are related to value-laden and culture-bound factors. As Hufton, Elliott, and Illushin, L. (2002) pointed out "perhaps more important are children's familial, peer, and cultural perceptions about what constitutes real and meaningful educational achievement and the extent to which this is seen to be of such intrinsic or extrinsic values as to evoke significant effort".

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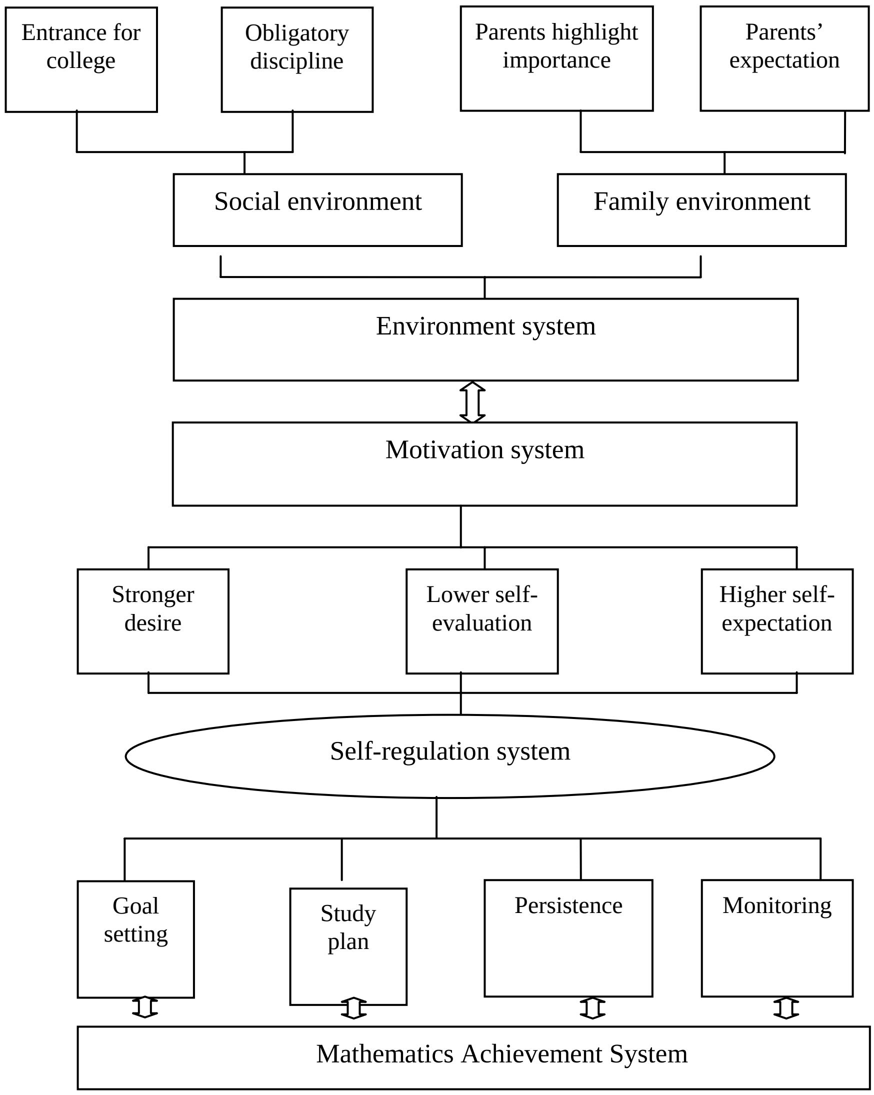

Figure 1. Causal model of Chinese culture-bound mathematics beliefs and achievement