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BOOK REVIEW

Windows on Mathematics Education Research in Mainland China: a thematic review

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A thematic review of the following books:

The Middle Path in Math Instruction: solutions for improving math education by Shuhua An, Lanham, MD, Scarecrow Education; 2004. ISBN: 9781578860890

How Chinese Learn Mathematics: perspectives from insiders edited by L. Fan, N.-Y. Wong, J. Cai and S. Li. London, World Scientific Publishing, 2004. ISBN: 9789812704146

Trends and Challenges in Mathematics Education edited by J. Wang and B. Xu. Beijing, East China Normal University Press, 2004. ISBN: 9787561738085

In 2000, ICMI (the *International Commission on Mathematical Instruction*) initiated a comparative study of school mathematics education practices in East Asian and Western countries. The focus for the study was what was roughly identified as the Chinese/Confucian tradition (on one side) and the Greek/Latin/Christian tradition (on the other). The aim was to examine, and learn from, the different cultural contexts in which mathematics is taught and learnt. The resulting book (Leung, Graf and Lopez-Real, 2006) provides an insightful examination of various cultural contexts, and is especially helpful in enhancing ways of understanding the varying forms of mathematics education that exist across different countries.

This thematic review continues the appreciation of different cultural contexts by examining three books - *The Middle Path in Math Instruction: solutions for improving math education* by Shuhua An, *How Chinese Learn Mathematics: perspectives from insiders* edited by Fan, Wong, Cai and Li, and *Trends and Challenges in Mathematics Education* edited by Wang and Xu (listed in alphabetic order by first author family name). Reviewing these three books, all published in 2004, provides the opportunity to gain insight into the practice of mathematics education research in mainland China, the country in which one in five of the world's population lives, and which has perhaps the world's oldest continuous civilization. Given that, until recently, only limited information in English was available about contemporary mathematics education research in China, the aim of this thematic review is to reveal some of the concerns of Chinese mathematics education researchers.

The book by Shuhua An (*The Middle Path in Math Instruction: solutions for improving math education*) is based on the author's PhD thesis completed in 2000. Contending that Ma (1999), in her comparative study, only considered teachers' *mathematical* content knowledge, Shuhua An focuses on teachers' *pedagogical* content knowledge (PCK). This is achieved through comparing the differences between the PCK of Chinese and American middle school mathematics teachers in terms of their beliefs about mathematics teaching and learning, their lesson planning, their use of teaching methods, and their knowledge of their students. Data was collected via a questionnaire completed by 33 Chinese teachers (from 22 schools in a large city in Jiangsu province in China) and 28 US teachers (from 12 schools in Texas, USA), and by observing and interviewing a total of ten teachers (five from each country). This sample, it has to be said, is comparatively small (something acknowledged by Shuhua An at the start of chapter 7), given that, according to the World Bank, there were some 111 million primary school children (aged 7-11) in China in 2000, and some 24 million in the US, and hence there would be many tens of thousands of teachers, perhaps millions. Despite this comparatively small data sample, the resulting book is not without ambition. For example, in setting the targets for her book, the author not only quotes her own words (from an article published in 2000) that "the most important dilemma for China is how to adopt western ideas in order to compete internationally, while at the same time not lose a culture that has survived for thousands of years" (p. 7), but she also sets her sights on contributing to solving the US "math wars" (of competing views on the most effective mathematics pedagogy) by finding "a middle road" which might "bring new inspiration to math education in the United States" (p. 8).

That said, there is much of interest in the book. Of particular interest, from the perspective of this review, are the accounts of a lesson from each of five Chinese teachers (pp. 152-181). These short vignettes are generally successful in conveying the gist of each lesson, although the limitations of written accounts are all too evident, as is the danger of over-interpretation by the observer. One apparent omission from the book is detail on the criteria for selecting the teachers. This is covered, however, in a related article (An, Kulm and Wu 2004, 150) which explains that, in addition to being current teachers and being willing to participate, the teachers had "at least three years of teaching experience at the fifth to eighth grade levels" and "only taught mathematics". This, it has to be said, does not necessarily provide particularly strongly comparable teachers, especially given the practice in mainland China of teachers giving "demonstration" or "open" lessons (i.e. open to other teachers to observe, see Ding and Jones 2006) to demonstrate their pedagogic skill. As such, the comparisons may not be altogether fair.

By the accounts provided in the book, the Chinese teachers were successful - certainly more so than seems to have been the case with the US teachers who were observed. Yet Shuhua An carefully follows, for the most part, her "middle path", in outlining "eight missing parts" of pedagogical content knowledge that appear to be absent, in some respects at least, from all the teachers, both Chinese and American (chapter 7). Throughout the book, Shuhua An argues that "pedagogical content knowledge is the key to the direction of mathematics education in both China and the United States" (p. 11).

Perhaps due to the relative slimness of the book, much of the evidence to support these conclusions needs to be taken more on trust rather than on judgment of data, for example, much of the account of the questionnaire data is in the form of summary percentages, and the descriptions of the lessons could be taken as more the view of the observer then necessarily reflecting the intentions of the teachers. Attention is drawn, however, to one possibly telling influence on the teachers' practice. As with evidence from major comparative studies such as TIMSS, differences in the working conditions of teachers can be immense. TIMSS revealed, for example, that mathematics teachers in Japan have substantially lighter teaching loads (with correspondingly more time to prepare lessons in well-provided conditions, plus they have more support in developing professionally) than do corresponding mathematics teachers in some other countries (see Jones 1997). In China, Shuhua An reveals, "most mathematics teachers only teach two periods of 45 minutes per day in the morning; the rest of the day is used for planning and grading" (p. 206), whereas in the US, the teachers in her study taught five periods of 45 minutes daily. That said, the Chinese teachers did have more than 50 pupils in their classes, compared to no more than 35 in the US classes. The trade-off seems to be between large classes but less teaching, compared with smaller classes with more time teaching. The influence of these working practices on teachers' pedagogical content knowledge is perhaps worthy of further study.

Shuhua An's experience of teaching mathematics in both China (at University level) and the US (at high school level) motivated her to "pursue and conduct comparative studies in mathematics education between the two countries" (p. 3). This review now turns to consideration of the two edited collections (*How Chinese Learn Mathematics: perspectives from insiders*, ed. Fan, Wong, Cai and Li, and *Trends and Challenges in Mathematics Education*, ed. Wang and Xu), as these provide windows on the concerns of some of the mathematics education researchers at work in mainland China.

A noteworthy feature of the book edited by Fan, Wong, Cai and Li is that eleven of the chapter authors work in mainland China. The book presents, as the editors acknowledge, "a starting point in our understanding of the phenomenon [of the Chinese learner]" (p. xii) through a set of chapters reflecting "a concerted effort…by a group of international researchers… who… have an insiders' experience, expertise, and, more importantly, a passion concerning Chinese mathematics education" (p. vii). Of the twenty chapters in the book, six are written, or co-written, by mathematics educators from mainland China. While it is these six chapters that are the focus for this review, it is worth noting that there is much of interest in the other fourteen chapters (including a series of six chapters providing an international perspective on the Chinese learner, plus other chapters on the themes of teaching materials, such as textbooks, and teaching approaches – with contributing authors being of Chinese descent and from, variously, Hong Kong, Taiwan, and the US).

In terms of the chapters written, or co-written, by mathematics educators from mainland China, the chapter by Zhang, Li and Tang focuses on what, since the 1960s, have been referred to in mainland China as the "two basics" of mathematics education, namely "basic knowledge and basic skills" (p. 192). As Zhang, Li and Tang explain, these "two basics" encompass, at suitable levels, "fast and accurate calculation", "fast and accurate manipulation of algebraic

expressions", "accurate memorization of definitions and formulae", and so on (p. 193). The pedagogic approach is to teach "only the essential, and ensure plenty of practice", with understanding and manipulation being "of equal importance" (p. 195). The authors point out that, over recent years, this focus on the "two basics" has been expanded to include mathematical modelling and applications, so that open-ended problems have been introduced into the curriculum and into the examination system.

Fan and colleagues (chapter 9) report on their investigation of how teachers and students use mathematics textbooks in China. Their findings concur with research carried out in other countries that textbooks are "the most important source for teachers to make decisions on what to teach and how to teach" (p. 158). Of particular interest are their findings that about half of the examples that the Chinese teachers used in their teaching were from sources other than the textbook, and that the more experienced the teachers became, the more they used textbooks in a flexible way. Gu, Hang and Marton (chapter 12) tackle what they call "the paradox of the Chinese learner" (p. 310) in that, to the casual observer, teaching in mainland China can appear as "passive transmission" (p. 310), yet the students perform well in tests and examinations. The explanation may be found, the authors suggest, in examining the way the Chinese teachers of mathematics "illustrate the essential features [of a mathematical concept] by demonstrating different forms of visual materials and instances, or highlight the essence of a concept by varying the non-essential features" (p. 315). This "theory of variation", as it is known, is being developed as an explanation of how Chinese teachers of mathematics successfully teach their students and is likely to have wider application.

Given that China is a huge country with enormous regional variations, Ma and her colleagues (chapter 15) focus on examining the similarities and differences between the teaching of mathematics in primary schools in urban and rural settings. The similarities they found include the intense level of oral communication between teacher and pupils, the central place afforded to the textbook, and that doing exercises occupies a large portion of teaching time. Differences include higher quality questions asked by urban teachers, and more varied and more flexible teaching from urban teachers. Several factors are suggested as explanations for these differences, including that urban teachers are better qualified, have more opportunities to interact with other teachers, and take a more active part in curriculum development and improvement.

Recent changes to the mathematics curriculum in China mean that probability and statistics are increasingly being found in the elementary and secondary school curriculum. The chapter by Li (chapter 16) reports on research examining the pros and cons of using a theoretical or an experimental approach to teaching probability. The author concludes that "introducing probability in an experimental approach or a theoretical approach cannot replace each other; each has its own role in helping students' understanding of probability" (p. 454). The chapter by Xu (chapter 18) reports on research into the effects of different representations, including computer-based representations, on the mathematics learning of primary school pupils. The author suggests that working with different representations helps pupils in their learning, with the pupils "more actively participating in constructing and analyzing mathematics concepts" (p. 495).

A noteworthy feature of *Trends and Challenges in Mathematics Education,* edited by Wang and Xu, is that it brings together papers from two events, an *International Symposium on Mathematical Education* held in Shanghai in 2001 and the *ICM2002 Satellite Conference on Mathematical Education* which took place in Lhasa, Tibet (ICM2002 is the 2002 *International Congress of Mathematicians*). Of the thirty papers in the book, nine are authored by mathematics educators from mainland China, the remaining chapters being authored by educators from around the world, encompassing a variety of topics such as assessment, the concept of school geometry, recommendations for statistics education, mathematics education in Malaysia, the use of technology, international comparisons, and issues in mathematics teacher education.

In terms of the chapters written, or co-written, by mathematics educators from mainland China, the chapter by Kong, Wang and Lam (chapter 3) reports on their study of the relationship between student engagement and learning outcomes in mathematics classrooms in Shanghai. The authors report that solving routine questions successfully is linked to student diligence, but also to student frustration and anxiety, such that "solving routine problems… could be a source of disinterest in mathematics amongst students" (p. 37). Jun Li (chapter 6) reports on student misconceptions in probability, finding, on the whole, similar issues to studies carried out elsewhere in the world, such as students "using part-part ration instead of part-whole ration" (p. 69).

The chapter by Xu (chapter 7) reports on a teaching experiment involving elementary pupils in which the pupils worked collaboratively on a "real-life" problem of planning an itinerary for some visitors to their city. The teaching experiment entailed the teacher taking on "an absolutely new instructional strategy" with the happy result that the pupils "became more independent and brave" (p. 80). Wang (chapter 13) reports on curriculum change in mathematics education in China that constitutes "unprecedented reform on a large scale". The aim of the reform is to "construct a new curriculum system for elementary and secondary education in China to meet the demands of the 21st century" (p. 159). Amongst the changes are a reduction in the coverage of complex calculations (eliminating ones that are more suited to calculators and computers), the introduction of probability and statistics into the curriculum, and reform of the geometry curriculum (including simplifying the demands for geometric proofs).

In chapter 14, Shiqi Li considers an ancient Chinese idiom that equates to "practice makes perfect" (p. 175). According to Li, while "many teachers in China, as well as in East Asia, believe it, and consider it a general principle for all kinds of learning" (p. 175), there is a negative side, as well as a positive side, to the saying. In Chinese, the word for practice means "both *familiarize with* and *be proficient at*" (p. 180, emphasis in original). This is the positive side. The negative side is that the "hard burden of meaningless practice could cause students' negative beliefs, attitudes and emotions" such that "practice makes them bored" (p. 182).

Langjie (chapter 15) reviews some of the issues in mathematics education in Tibet. These include the need for advances in mathematics education to be sensitive to the Tibetan culture, for greater investment in Tibetan mathematics education to be made, and for improvements to be made in the professional knowledge of Tibetan mathematics teachers. Jiang (chapter 16) examines the experience of mathematics students at Tibet University. Recommendations from

the study include the suggestion for Tibetan-Mandarin bilingual teaching, and for efforts to take account of the Tibetan culture in devising teaching activities.

Zheng (chapter 22) reflects on the nature of curriculum change in mathematics education in mainland China, noting that "the whole system of education in modern China, including the organization of schools, the design of curriculum and the teaching methods, is chiefly introduced from abroad (including both Western countries and the former Soviet Union) and therefore is in conflict, more or less, with the host cultural tradition…" (p. 289). Zheng cautions that comparative studies need to be designed carefully if they are going to be worthwhile and avoid over-simplification. The way to proceed with curriculum change, Zheng advises, is "not to introduce things without thinking, but rather do our best to make clear firstly their nature and especially their advantages and disadvantages and then make the necessary changes or modifications to make them adapt to our culture" (p. 290). The chapter by Wang (chapter 30) concludes the book, and examines the power of concepts in mathematics and its teaching, arguing that mathematical concepts are "key links" in mathematics education, in that they "bridge concreteness and abstractness, intuition and logic" (p. 402-403).

This set of books provides a valuable window on the work of a range of mathematics educators from mainland China. Shuhua An, in her book, provides some insights into teachers' pedagogical content knowledge (PCK). The edited collection by Fan, Wong, Cai and Li (*How Chinese Learn Mathematics: perspectives from insiders*) is a significant contribution to the research literature and provides an important resource in the field. Likewise, the edited collection by Wang and Xu, *Trends and Challenges in Mathematics Education*, while less focused than the collection by Fan etc, is also a significant resource, placing chapters by mathematics educators from mainland China alongside works by researchers from other countries around the world.

The choice of topics tackled by the various mathematics educators from mainland China across the three books is instructive. Across the various research studies, there is a clear focus on both the design of the mathematics curriculum and on forms of mathematics pedagogy. Curriculum change is clearly a major concern, as is, in terms of pedagogy, what is entailed by the "two basics" and the idiom that "practice makes perfect". Developing pedagogy is also a key concern, with reports of studies of experiments in teaching probability, in using different mathematical representations, and in teaching using "real-life" problems. Sensitivity to local cultures is also evident, with a consideration of urban and rural settings, and of regional settings such as major cities like Shanghai and regions like Tibet.

Across the reports presented in these three books, there is evidence of a strong methodological awareness, and of how research needs to be carefully designed if it is going be worthwhile and avoid over-simplification. There are also promising contributions to theory, including theories of teachers' pedagogical knowledge and the "theory of variation".

In relation to my own work as a mathematics educator and researcher, I was struck, in particular, by the work on comparing cultural settings (especially Zheng on international comparisons, and Shuhua An on comparing teachers' knowledge), on teaching methods (for instance, Gu and colleagues on the "theory of variation"), on the relationship between conceptual and procedural knowledge (including Zhang and colleagues, Shiqi Li, etc), and on the design of the mathematics

curriculum (for example, Wang). Together, this set of books provides unparalleled insights into the concerns of mathematics educators in mainland China. As such, the books are an invaluable resource, not only as a window on mathematics educators in mainland China but also, crucially, as a mirror in which to reflect on approaches and concerns in other countries around the world.

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