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## Mathematics Instruction Across Two Cultures: A Teacher Perspective

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International studies (e.g., Program for International Student Assessment, 2009; Trends in International Mathematics and Science Study, 2007) indicate that the educational system in the U.S. lags behind China in mathematical preparation. Prior studies have made cross-cultural comparisons between U.S. and Chinese mathematics education, but few, if any, have done so from the perspective of the classroom teacher. This study, drawn from U.S. teachers' own perspectives, aims to compare Chinese and U.S. elementary mathematics instruction. As authors of this study, we are elementary teachers who taught similar mathematics lessons with identical objectives as our Chinese counterparts. We also had an opportunity to visit Chinese classrooms in person and participated in conversations about teachers support and preparation in both countries. Through comparative analysis of our findings, the eventual goal is to contribute to discussions about ways to improve our mathematics teaching and learning in the United States. We ask two questions: a) How does mathematics instruction in the compared lessons of the two countries differ? b) How do teacher support and preparation in the two countries differ?

### **Literature Review**

To facilitate positive instructional change, cross-cultural study is imperative because it allows identification of alternative approaches that may not be available when one limits the eyesight to own nation (Stigler & Hiebert, 1999). Previous studies found that there is a correlation between countries with higher levels of mathematics achievement and their emphases on teacher development, with regard to improving the methodologies they use in the classroom, as evidenced by lessons that focus around problem solving investigations from which procedures are developed (e.g., Hiebert & Stigler, 2004; Stigler & Hiebert, 1999). This is in contrast to U.S. classrooms in which there is a tendency to focus on terminology and practicing procedures that do not require the same level of deep thinking (Stigler & Hiebert, 1999). Ma (1999) finds that, while Chinese teachers may receive less formal education, they possess a more profound

understanding of elementary mathematics, due to systemic differences in which teachers of mathematics receive earlier training and, as specialists with a lighter teaching load than their U.S. counterparts, have regular time to engage in collegial study and planning that continually deepens their mathematical understandings and leads to refinement of their teaching methods. This is confirmed by Li and Huang (2008) who found that Chinese teachers' in-depth of understanding of the content they are teaching may be attributable to highly effective systems of teacher support. In fact, there is a gap between expert and novice Chinese teachers' knowledge about the curriculum they teach and their solid mathematics knowledge for teaching, with expert teachers using a greater variety of conceptual strategies than their novice peers. This evidence supports the value Ma (1999) places on collegial study as a mechanism to improve teacher practice. Prior studies including the above have provided a base for this study. However, those studies are mainly from perspectives of researchers. Very few have compared U.S. and Chinese mathematics education from the perspective of the classroom teacher. This study aims to address this literature gap by exploring teachers' views on differences in US and Chinese mathematics classroom teaching and teacher preparation.

## **Methods**

### **Participants and Project**

In this study, we as participating teachers of a five-year NSF project, used project data to conduct qualitative analysis centered on our two research questions. The large project involves a total of 20 US and 17 Chinese expert elementary teachers (grades 1-4) with the goal to identifying necessary knowledge for teaching algebra. All teachers (except for 1) has over 10-year teaching experiences and has good teaching reputation. For instance, all Chinese teachers won teaching awards at different national or local levels; all US teachers were recommended by their principals or the school district with some are National Board Certified. The US teachers

came from eight different schools from a large urban School District in the East Coast. This is a district with over 300,000 students that come from a variety of economic backgrounds. In years one and two of the study, teachers in both countries were videotaped teaching an algebraic lesson with the same objective covered. During year three, teachers from both the U.S. and China received project intervention which contained insights gleaned from the US and Chinese videos. In year four, 12 US and 12 Chinese teachers retaught the same lesson incorporating what was learned from the project. Also, in year four, nine teachers from the U.S. visited four schools in two Chinese provinces.

### **Data Sources and Procedures**

For this action research, our data was drawn from four sources. First, we studied data from a video forum that we participated in. As mentioned above, during the first two years of the project, teachers in both countries were first videotaped teaching algebraic lesson with identical objectives. The project researchers then examined the videos and annotated 25 typical US and Chinese video clips with different aspects of teaching merits. These videos were uploaded to two identical online platforms for a one-month video forum during year 3 of the project. As part of the participation, we watched the video clips and commented online on the following questions: (a) What do you notice? What stood out to you? (b) What questions do you have in terms of this video or in general? And (c) Other comments? After the online video-forum, we participated in a 3-day face-to-face workshop hosted by the project researchers. During this onsite workshop, we revisited some of the videos, reflecting on what we have learned from the Chinese classrooms and what we may transfer some of the approaches to our own classrooms. All of the video forum data were collected and shared with us for data analysis.

The other three data source came from our Chinese classroom visit in year 4 of the project. For this China trip, the project researchers selected nice teachers based on various criteria. The

authors of this study are part of this China trip group. Overall, the visit to China provided a first-hand account of the Chinese educational system. During this trip, we first participated in a mathematics education conference, which was held at a Normal University. This conference focused on lesson design and instructional approaches from a cross-cultural perspective. In addition to presenting our own talk, we learned more information about Chinese teachers' mathematics design that goes beyond the project Chinese teachers. Next, we participated in a teaching exchange including a total of twelve demonstration lessons taught by either our US group and a few Chinese teachers. Following the demonstration lessons, teachers from both countries and Chinese school administrators met to discuss pedagogical issues and available support for teachers. Finally, right before returning to the US, we were engaged in detailed reflection on what we had learned from the China trip. Each one of the above research events was video or audiotaped, and extensively documented.

### **Data Analysis**

The project researchers shared the data sources with us for our action research analysis. To answer our first question about classroom instruction, we mainly analyzed the video data, our comments on video forum, and our reflections on the Chinese lessons we observed during our China trip. To answer our second research question about teacher support and preparation, we mainly reviewed the conversations with Chinese administrators and teachers as well as the information we gathered from the conference in China. For each set of data, we first reviewed them with memo writing. This led to a generation of key categories for each research question. We then compared the categories to come up with a few key themes. To ensure the validity, we conducted peer debriefing ensuring what we reported represented the actual voice of our teacher group. In the following section, we will report our findings to each of the research questions.

## Results

### How does Mathematics Instruction in the Sampled Lessons of Two Countries Differ?

In terms of classroom pedagogy, we note several cross-cultural differences, which seemed to be attributed to curriculum differences. The first difference was related to the use of visual representations. The Chinese lessons always begin with an image of a real-life situation which provides a contextual support for students to explore the targeted concept. The same cannot be said of U.S. math lessons. Most often, visual representations in textbooks do not represent the situational topic of a lesson; they may relate to the subject but not the mathematics of given problems. Consequently, U.S. teachers are far more likely to begin lessons by recording an equation and making real-world connections only after these symbolic representations have been presented. Figure 1 illustrates an example during which the US and Chinese teachers taught a similar lesson about fact family. In the U.S. lesson example, the teacher starts with an equation relating facts, as to where in the Chinese Lesson the teacher starts with a visual and the students create the fact family that relates to the images (see Figure 1). The US example reflects a common view named symbol-precedent review reported in prior studies (e.g., Nathan, Long, & Alibali, 2002).

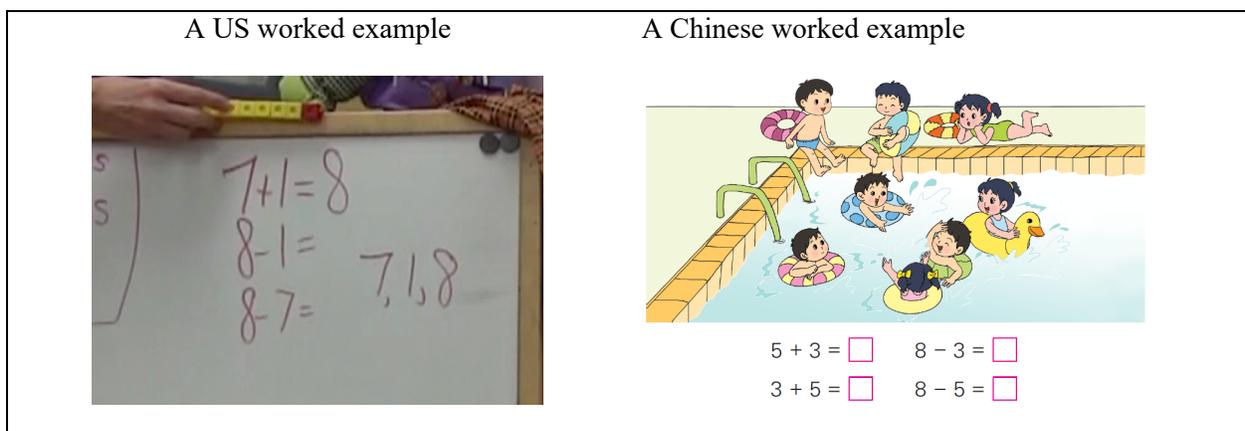
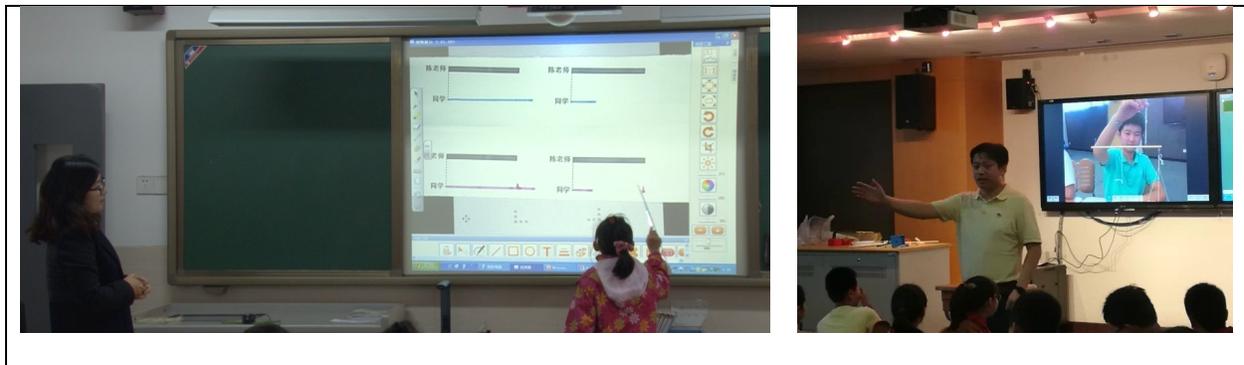


Figure 1. Initial presentation of a worked example task in US and Chinese lessons.

Another pedagogical difference is in the number of mathematics problems included in a lesson. Chinese lessons are comprised of far fewer problems than U.S. lessons, allowing for greater depth of conversation and deeper understanding. A focal point of Chinese lessons, the “worked example,” allows students considerable time to develop ideas. These engaging, real-world situations serve as the basis for scaffolding concepts to be mastered. Use of handheld devices that immediately project student work enables analysis of students’ approaches to the “worked example” and promotes plurality in pathways to understanding (see Figure 2). Chinese teachers call on several students to share their observations, solutions, and understanding. This practice promotes proficiency in the use of mathematical vocabulary and discourse. By contrast, U.S. lessons tend to include far more problems, requiring students to move quickly through tasks without sufficient time for reflection. As a result, students in U.S. classrooms do not have as many opportunities to develop their mathematical vocabulary and reasoning skills. This again aligns with the pattern of textbook differences. In China there is a national curriculum with only three publishing sources to receive curriculum materials from. In contrast to the United States, where there are many more selections of published materials to choose from.



*Figure 2.* Chinese teachers’ intensive discussion of one example task that involves student solutions.

The third difference lies in the rigor of lesson structure, which is embedded in the curriculum itself. For instance, in Chinese lessons, the objective is a summative statement, naturally arrived at through the development of thinking. The contextualization of math

concepts, use of hands-on activities, and asking of deep questions, allows teachers to unfold concepts in increasing depth, developing understanding of vocabulary, exemplification of terms, application of skills, and justification of thinking. It is through these means by which objectives are derived. By contrast, in U.S. lessons, the objective is directly given to students from the start and exercises that follow are merely a check of facts that have been provided. Of the two, the Chinese structure is clearly more cognitively engaging and demanding.

### **How does Teacher Support and Preparation in the Two Countries Differ?**

While many cross-cultural distinctions are attributable to curriculum differences, others emerge from systemic dissimilarities. For example, we note that larger class size in China (approximately 40-50 children) and shorter class periods (approximately 40 minutes) necessitate efficiency in delivery of instruction. We are interested in exploring how we might more tightly organize our own instruction. Differences in how elementary school teachers are certified in each country is another systemic contrast worthy of note. While U.S. elementary teachers tend to be generalists who teach every subject area, Chinese teachers are specialists. These Chinese mathematics specialists' loop with students across grades, often throughout their entire elementary years. Thus, Chinese teachers acquire both deep content understanding and cross-level competencies while Chinese students benefit from continuity of instruction. Because of the specialist role, Chinese teachers tend to teach only two 40-minute periods per day. This gives them ample time to collaboratively plan, grade student work, and provide differentiated instruction for individual children in need of support.

In addition to the cultural disparities in teacher preparation and assignment, variations in the nature of support and professional development also likely impact differences in instruction. In the United States, teacher observations generally occur a prescribed number of times per year and are undertaken by a building administrator to establish teacher ratings, in compliance with a

designated set of standards. Since observations are often limited in quantity and/or scope, feedback may have a limited impact on teachers' professional growth. Faculty development sessions are often prescribed by the school district, irrespective of the needs of individual schools. Conversely, in China, schools utilize teaching and research activities that increase transparency, feedback, and therefore teacher reflection and development, similar to the Japanese lesson study. In China, teachers regularly teach lessons before other teachers and administrators to receive critical feedback from varied perspectives. Figure 3 shows two classrooms used for demonstration lessons or teaching and research activities in two different cities we visited. In fact, the picture on left indicates the teaching exchange activity we were involved during our China trip. Furthermore, Chinese principals who are subject matter experts themselves serve as instructional leaders and drive professional development of their staffs. These practices give Chinese teachers many opportunities to learn from each other, receive training relevant to their instruction, and to refine their craft.



*Figure 3.* Teaching and research activities are common practices in China.

## **Discussion**

As a result of observed lessons and interactions with Chinese educators, we have developed expanded understandings of the ways that teacher preparation, professional development, and assignment translate into targeted, carefully planned instruction based on prior learning and driven by deep questions posed to students. The findings of our observations and

interactions with Chinese colleagues were consistent with the research (Stigler & Hiebert, 1999 and Ma, 1999). In all schools visited, observation of instruction by Chinese teachers revealed a progression in the instructional path that started with a concrete situation, developed mathematical language and procedures through engagement with a singular worked example that included continuous review, connection, and probing questions to develop students' mathematical reasoning. Lessons culminated with derivation of an objective. While we recognize that structural differences between our two countries will persist, we believe, nonetheless, that there is much we can learn from China. As teachers, we are convinced of the need to continue collaborating in order to continue the co-construction of knowledge that emerged from our China experience. We are also convinced of the need to share our learning with a wider audience. In particular, we are grappling with questions about curriculum design as well as professional development for teachers, which may be pursued by mathematics educators, researchers, curriculum designers, and beyond. For example, how might current published materials be changed or used in modification by U.S. teachers of mathematics to be more reflective of the Chinese approach in which there is a more cohesive development of a single worked example from concrete to abstract? In addition to time required to make such modifications, can schools or school systems build in more time for teachers to collaborate by planning, discussing math problems and approaches that yield understanding and not just solutions? Would it benefit U.S. schools to have elementary teachers specialize in their content areas to promote teachers' expertise? Individual teachers can make small changes within their own classrooms, but without systemic changes, a lack of continuity with methodologies across grade levels would likely yield little cumulative effect. If we are to develop students who thoroughly understand procedures in a way that allows them to consistently and effectively analyze new problems and apply appropriate strategies, we need to focus less on the programs

we are given and more on the methods that make math meaningful. To that end, it is recommended that strides be taken to use China as a model to emulate in U.S. mathematics classrooms.

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