DOCUMENT RESUME

ED 421 344 SE 061 540

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TITLE A Cross-National Comparison of Fourth-Grade Mathematics Instruction in the United States and China.

PUB DATE 1998-04-16

NOTE 18p.; Paper presented at the Annual Meeting of the American Educational Research Association (San Diego, CA, April 13-17, 1998).

PUB TYPE Reports - Research (143) -- Speeches/Meeting Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.

DESCRIPTORS *Cross Cultural Studies; Educational Assessment; Foreign Countries; *Grade 4; Intermediate Grades; *Mathematics Achievement; *Mathematics Instruction; Mathematics Teachers; Self Efficacy; Teaching Methods

IDENTIFIERS China; United States

ABSTRACT

The superiority of Asian students in cross-cultural comparisons of mathematical achievement has been well documented. U.S.-Chinese comparative studies have investigated a variety of factors related to student achievement in mathematics including societal and cultural influences, and student and school characteristics. This study investigates the similarities and differences between Chinese and American teachers in three areas: 1) sense of personal efficacy in teaching mathematics; 2) perceived ability to improve mathematics instruction; and 3) perspective on the relationship between lesson preparation and delivery and student mathematical understanding. Fourth grade teachers were randomly selected--79 in China, 50 in the United States--to receive the survey. Smaller random samples were audio or videotaped teaching mathematics and interviewed regarding their mathematics instruction. Results indicate that many similarities exist between Chinese and U.S. teachers with regard to perceived competence, effort, and the importance of assessments and student studying of material to success in mathematics. (Contains 17 references.) (ASK)

A Cross-National Comparison of Fourth-Grade Mathematics Instruction in the United States and China

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Paper presented at the Annual Meeting
of the
American Educational Research Association

San Diego, CA
April 16, 1998

Introduction

The superiority of Asian students in cross-cultural comparisons of mathematical achievement has been well documented (Lapointe, Mead, & Phillips, 1989; McKnight, Crosswhite, Dossey, Kifer, Swafford, Travers, & Cooney, 1987; Stevenson, Lummis, Lee, & Stigler, 1990; Stevenson & Stigler, 1992; Stigler, Lee, Lucker, & Stevenson, 1982; Stigler, Lee, & Stevenson, 1987). Within the last decade, as data on the mathematical achievement of Chinese children have become more readily available, U.S. - Chinese comparative studies have yielded similar results (Cai, 1997; Cai & Silver, 1993; Stevenson, Chen, & Lee, 1993; Stevenson & Lee, 1990; Stevenson, Lee, Chen, Lummis, Stigler, Fan, & Ge, 1990; Stevenson et al., 1990; Stevenson & Stigler, 1992; Stigler, Lee, & Stevenson, 1990; Stigler & Perry, 1988; Uttal, Lummis, & Stevenson, 1988).

Typically, U.S. - Chinese comparative studies have investigated a variety of factors related to student achievement in mathematics, including societal and cultural influences and student and school characteristics. In addition, these studies have compared curricula, teacher preparation programs, teaching schedules, classroom organization, and student time spent studying mathematics. In spite of numerous cross-national comparisons of mathematics achievement between U.S. and Chinese students, however, more in-depth information is needed regarding the interrelationships among teachers' classroom behaviors and their professional preparation, approaches to lesson planning, and beliefs about mathematics instruction. This study investigates the similarities and differences between Chinese and American teachers in three areas: a) sense of personal efficacy in teaching mathematics; b) perceived ability to improve

mathematics instruction; and c) perspective of the relationship between lesson preparation and delivery and student mathematical understanding.

Review of Literature: Cross-national Studies of Teachers of Mathematics

Teachers of mathematics vary cross-culturally in the amount and kind of mathematical and instructional methods training they have received. A comparison of American and Chinese teachers in Stevenson and Lee's (1990) large scale study found that of the 40 American teachers surveyed, all were college graduates and 11 had advanced degrees. Ninety percent of the Chinese teachers were graduates of a teacher training program that they entered after completing middle school.

The training of Asian teachers, including Japanese, Chinese, and Korean teachers, is not limited to the universities, and the focus of Asian teachers' education is different from American teachers' education (Kobayashi, 1993; Shimahare & Sakai, 1995). Asian pre-service teachers are more likely than Americans to major in liberal arts and to take courses in substantive disciplines such as literature or mathematics, rather than methods for teaching these subjects. Kobayashi (1993) reported that "universities and colleges are the places where pre-service education for future teachers takes place...they are authorized by the Ministry of Education first as institutions of higher learning and secondly as teacher training institutions" (6). American teachers-in-training generally major in education, and take many courses in teaching methods. Asian teachers receive the majority of their methods instruction when employed after graduation.

Asian teachers are assigned by the government to a school, where they are considered novices, and formally enculturated to teaching practices by master teachers. Asian teachers by law must receive a minimum of twenty days of in-service training

during their first year on the job. Master teachers within the school are given one year leaves of absence to supervise the training of new teachers, providing observational feedback, suggestions for improvement, and counseling regarding effective teaching techniques. Asian teachers are involved in organized weekly meetings where teaching lessons and techniques are shared and discussed. "A whole meeting might be devoted to the most effective ways to phrase questions about a topic or the most absorbing ways of capturing children's interest in a lesson" (Stevenson & Stigler, 1992, 160). Chinese teachers also share ideas while preparing lessons in a large central room designed with a desk for every teacher, and have videotapes of demonstration lessons available that cover the whole curriculum (Stigler & Stevenson, 1991).

Minimal differences seem to exist between China and the U.S. in terms of teacher age, years teaching, and gender. The average age of American mathematics teachers in the Second International Math Study (SIMS) eighth grade sample was 37 years old, with 13 years of teaching experience. Teachers had an average of eight years teaching experience in eighth grade (Crosswhite, Dossey, Swafford, McKnight, & Cooney, 1985; McKnight, Crosswhite, Dossey, Kifer, Swafford, Travers, Cooney, 1987). Stevenson and Lee (1990) reported an average of 15 years of teaching experience for their American sample of 40 elementary teachers, and an average of 17 years for Chinese teachers. Ninety percent of the American and eighty percent of the Chinese teachers were female.

The make-up of a teachers' school day varies across cultures. The amount of time spent at school each week by Chinese teachers was 47 hours, and American teachers 42 hours. Teaching occupied an average of 28 hours each week for American teachers; Chinese teachers spent an average of 30 hours (Stevenson and Lee, 1990). Chinese

teachers teach five and one-half days per week, while American teachers teach five days per week. A greater percentage of each day's time is spent teaching by American teachers.

The number of hours spent in instruction of students, and the number of different subjects taught also varied across cultures. Chinese teachers teach no more than three hours a day, while U.S. teachers teach an average of five hours per day. During the first three grades the teaching assignment of Chinese teachers includes both reading and mathematics; for the upper three grades of elementary school, teachers typically specialize in one of these subjects. Elementary teachers (grades one through six) in the U.S. typically teach all academic subjects. Chinese teachers spend the rest of their day at school carrying out other responsibilities to their students and school. (Stevenson & Stigler, 1992). One of the greatest problems reported by over 50 percent of American teachers was the difficulty of meeting the demands on their time, both inside and outside their classrooms. Only 10 percent of the Chinese teachers reported time demands as a problem.

Teachers' perceptions regarding teaching mathematics were compared across cultures in SIMS. American teachers reported that mathematics was rather easy to teach, while Asian teachers stated that mathematics was difficult to teach (McKnight et al., 1987). When teachers were asked to give reasons for the lack of desired progress of their students in mathematics, teachers in the United States offered answers relating to students, such as student misbehavior, lack of attention, or poor attendance. In contrast, Asian teachers tended to attribute lack of student achievement to their own professional limitations.

Sampling

Selection of Chinese Sample

Twenty urban, public elementary schools in Beijing, China, were randomly selected by researchers at Beijing Normal University. School principals were asked for permission to conduct a survey of their teachers. Seventy-nine fourth-grade teachers were randomly selected from the schools to complete a survey. The survey was distributed and collected by Beijing Normal University researchers. The Chinese portion of the sample consisted of seventy-nine fourth-grade teachers (14 males and 65 females), with the following numerical distribution relating to subject areas taught: 25 language arts and 4 other subjects; 35 math; and 12 language arts and math (three did not specify subject area taught). The mean age of the Chinese sample was 34 (range 19-54 years), with a mean number of years taught of 14 (range 1-34 years). The Chinese teachers' educational background included: 6 completing middle school; 65 completing teacher school; and 8 with a college degree.

Selection of U.S. Sample

Five school districts near a large city in Washington state were contacted and asked to participate in the cross-national project. Four districts agreed to participate, including one rural district with one elementary school, and three suburban districts with 13, 7, and 3 elementary schools each. A total of 23 schools comprised the sample, with approximately three fourth-grade teachers per school. Fifty fourth-grade teachers were randomly selected to receive the survey. Of those 50 selected teachers, 29 returned the survey, for a 58% return. The U.S. sample of 29 teachers included 7 males, and 22

females, with a mean age of 46 (range 25-56 years), and a mean number of years taught of 17 (range 1-32). All U.S. fourth-grade teachers in the sample teach all academic subjects in the classroom.

The U.S. teachers' educational background included: 5 completing a bachelors degree; 6 completing a post-baccalaureate certification program; and 18 completing masters degrees. The U.S. teachers reported taking a mean of four college/university semester courses in mathematics, three courses in instructional methods of mathematics; and attending five or more workshops, conferences, or in-services which focused on mathematics instruction. Teachers reported spending an average of 15-30 minutes (range 15 minutes to 1½ hours) preparing to teach a single mathematics lesson.

Procedures

The study discussed in this paper is part of a larger study currently underway. Fourth-grade teachers in both China and the U.S. have been surveyed, and a smaller, random sample have been either audio or video taped teaching mathematics and interviewed regarding their mathematics instruction. The results of the classroom observations in each sample group will be presented at a later date. Chinese students have also taken achievement tests administered by the Beijing researchers.

Researchers at Beijing Normal University initially developed a two part questionnaire to be distributed to elementary teachers during the 1996-97 school year. The first part of the questionnaire included 10 questions related to teacher efficacy. The second part included 14 questions that asked teachers to rate themselves in the following areas: (a) willingness to utilize improved, but unfamiliar instructional methods; (b) relationship of teaching to student achievement; and (c) instructional competence and

effort. Teachers circled their rating using a 5 point Likert scale. The questions were translated by the Beijing researchers from Chinese to English. The U.S. researchers included twelve of the questions from the second part of the survey in a larger survey given to the U.S. teachers. Additional items included in the survey addressed: demographic information, such as gender, degree, age, and years taught; mathematics content and instructional methods preparation; and perceived mathematics instructional needs.

U.S. surveys were mailed to principals in each school to be delivered to randomly selected fourth-grade teachers at their school. Teachers mailed their responses back to the researcher. One follow-up mailing was used after two weeks to teachers who had not responded within the specified return date. Chinese surveys were delivered to schools, and collected by the Beijing researchers.

The twelve corresponding survey items were analyzed using analysis of variance (ANOVA) to determine differences between the three Chinese teacher groups based on subjects taught, specifically: mathematics; language arts and other; and language arts and mathematics. T-tests were utilized to determine differences between all Chinese and American teacher responses to each of the 12 survey questions.

Results and Discussion

ANOVA indicated no significant difference between Chinese subgroups of teachers on ten of the twelve survey questions. The two questions that yielded a significant difference between Chinese teacher subgroups were analyzed with t-tests comparing each subgroup to the U.S. sample responses.

Use of "New" Teaching Methods

Cross-national comparison of teachers' responses to two methods-based questions resulted in a significant difference. Teachers were asked to rate their willingness to use new teaching methods (5=quite possible, 1=absolutely impossible). The two questions asked teachers' opinions regarding their willingness to: 1) try a new method of teaching mathematics to students that will help students understand the mathematical concepts better, but is more difficult for the teacher to learn, and the teacher could make mistakes the first time they try using the method; and 2) using a method that is very familiar to the teacher, but is not as effective in promoting student learning. U.S. teachers were more willing to try the new instructional mathematics method than their Chinese peers, with means and standard deviations (in parenthesis) of 4.48 (0.57), and 4.01 (0.87), respectively, $t(104)=2.72$, $p<0.01$ (see Fig. 1). In addition, Chinese teachers reported that they were more likely to use the more familiar method, mean= 4.29 (0.65), than U.S. teachers, mean=3.28 (1.13), $t(104)=4.80$, $p<0.001$ (see Fig. 2). There was no significant difference between Chinese sub-groups of teachers.

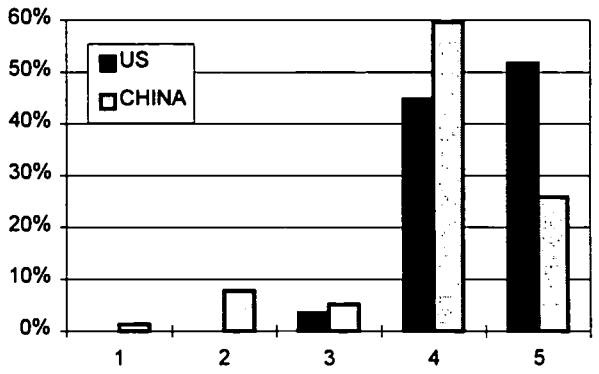

Fig. 1. Frequency distribution: Teacher willingness to try new instructional method (1=absolutely impossible, 5=quite possible).

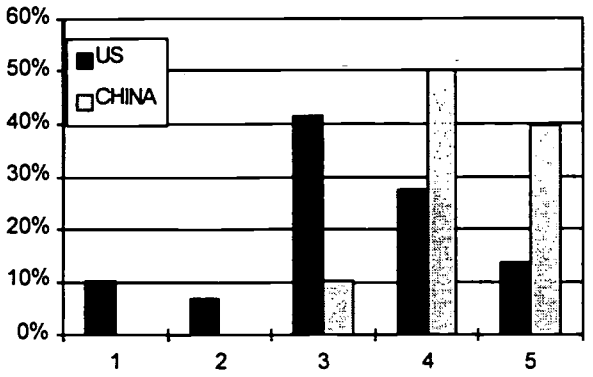

Fig. 2. Frequency distribution: Teacher willingness to continue with familiar method (1=absolutely impossible, 5=quite possible).

The wide variation in curriculum in U.S. schools, versus a strict national curriculum in China may partially account for the differences between Chinese and U.S. teachers regarding choice of instructional methods (Stigler et al., 1982). U.S. teachers may also be more willing to try new methods because of the typical limited communication between grade-level teachers regarding mathematics instruction, resulting in limited sharing of success in instructional methods. Chinese teachers, in contrast, spend more time discussing mathematical instructional methods with teaching colleagues, and may feel more confident in their instructional methods that have developed through discussion with peers (Stevenson & Stigler, 1992).

Influences on Students' Mathematical Success

When asked what factors influence their students' mathematical success, there was no significant difference between Chinese and American teachers' beliefs regarding the low difficulty level of assessments, or studying of material by students. Chinese teachers rated their hard work as a teacher as a greater factor than U.S. teachers, (5= very

important, 1=very unimportant), with means ratings of 4.69 (0.57), and 4.21(0.56), respectively, $t(104)=2.72$, $p<0.01$ (see Fig. 3). There was a significant difference between Chinese sub-groups of teachers related to their ratings of studying by students: mathematics, mean=4.74(1.31), N=34; language and mathematics, mean=4.08 (1.31), N=12; and language arts and other, mean=3.10 (1.56), N=29, $F(2,74) = 15.80$, $p<0.001$. However, there was no significant difference between U.S. teachers' ratings of student studying and Chinese subgroup ratings.

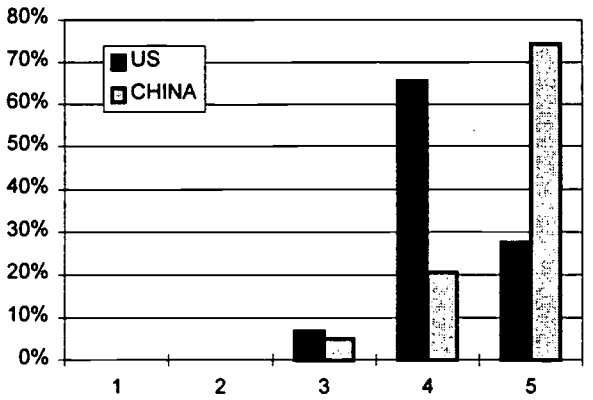

Fig. 3. Frequency distribution: Teacher hard work and high student mathematics achievement (5=very important, 1=very unimportant).

Influence on Students' Poor Mathematical Performance

Teachers' responses to the factors influencing students' poor performance mathematically resulted in no significant difference between Chinese and U.S. teachers in the areas of difficulty of student assessments, or lack of students studying required material. There was a significant difference between Chinese subgroups' ratings of teacher competence as a factor of poor student performance: mathematics, mean=3.97 (0.82), N=34; language and mathematics, mean=4.25 (0.87), N=12; and language arts and

other, mean=3.33(1.49), N=29, $F(2,74) = 3.82$, $p<0.05$. Chinese teachers again reported that their lack of hard work influenced student performance more than their American counterparts: Chinese mean=4.09 (1.06); U.S. mean=3.21 (1.23), $t(104)=3.66$, $p<0.01$ (see Fig. 4).

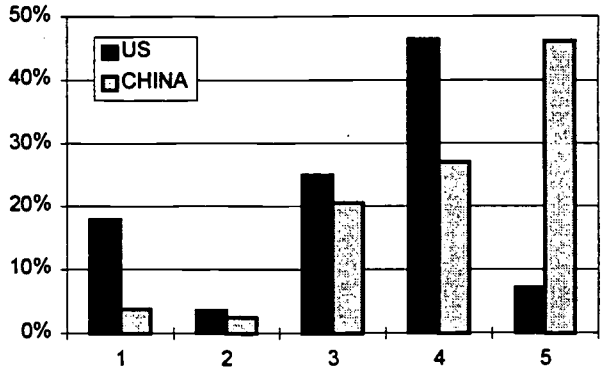

Fig. 4. Frequency distribution: Teacher lack of hard work and poor student mathematics achievement (5=very important, 1=very unimportant).

Chinese teachers reported that their students' ability to do well, or not do well, in mathematics was influenced by the teacher's hard work. This is consistent with the SIMS findings regarding Asian teachers' perception of mathematics teaching as a "difficult, demanding enterprise, the success of which had considerable impact on the achievement of their students" (McKnight et al., 1987). U.S. teachers also reported that the teacher's hard work influenced student achievement, but not as greatly as reported by the Chinese teachers. The difference in beliefs regarding teacher effort and student achievement may be related to cultural perception differences as described by Stevenson and Stigler (1992). In the Chinese culture, students, parents, and teachers subscribe to the *effort* model of learning. Achievement is directly related to the amount of effort exerted. In contrast,

American students, parents and teachers seem to ascribe to the *ability* model, where motivation to try hard depends on the student's confidence in their perceived innate abilities. Chinese teachers feel that if they work hard, their students will be more successful, and conversely, if they do not work hard, student success will suffer.

Teachers' Self-perceptions of Competence and Effort

Compared to other teachers in their school, U.S. and Chinese teachers' ratings of their competence and effort in mathematics instruction resulted in no significant difference cross-nationally, or within Chinese subgroups. When questioned regarding the importance of teacher competence on student success, U.S. teachers' mean=4.48 (0.69), and Chinese teachers' mean=4.45 (0.66) (5=very important, 1=very unimportant). When students did not succeed in mathematics, U.S. teachers rated the importance of their own lack of competence as mean=3.83 (1.04), and Chinese teachers' mean=3.82(1.10). Overall, U.S. teachers rated their competence in mathematics instruction as mean=3.58 (0.50), and Chinese teachers' mean=3.37 (0.63), with a rating scale of 1=the lowest, 5=the highest (see Fig. 5). In regard to teacher effort in mathematics instruction, U.S. mean = 3.79 (0.49) and Chinese mean=3.79 (0.63) (see Fig. 6).

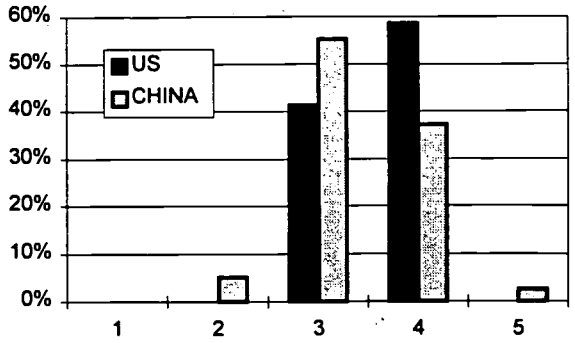

Fig. 5. Frequency distribution: Teacher competence in mathematics instruction as compared to other building teachers (1=the lowest, 5=the highest).

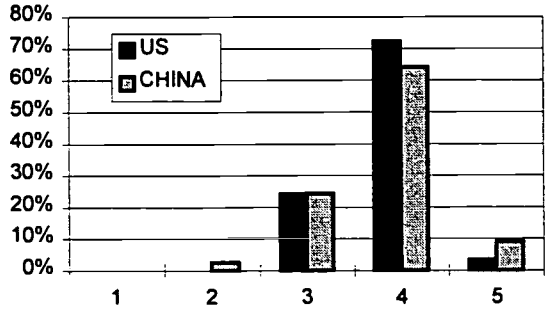

Fig. 6. Frequency distribution: Teacher effort in mathematics instruction as compared to other building teachers (1=the lowest, 5=the highest).

The similarities between Chinese and U.S. teacher ratings regarding their perceived competence in mathematics instruction indicate that teachers from both countries believe that student success in mathematics is strongly related to teacher competence. Both groups of teachers rated the influence on student mathematical success of teacher competence as between *important* and *very important*. When students are not successful in mathematics, both Chinese and American teachers reported that the importance of teacher competence is between *neutral* and *important*. The competence of

the teacher, in both countries, was seen as a having a greater influence on student success, than on student lack of achievement in mathematics. Both groups of teachers rated their competence in mathematics instruction between *average* and *above average*, indicating that they felt competent teaching mathematics.

Chinese and American teachers reported very similar ratings of their effort, as compared to other teachers at their school. Both groups rated effort as between *average* and *above average*. These similar results cross-nationally raise questions regarding the actual influence of teacher competence and effort on differences cross-nationally in student achievement (Stevenson et al., 1986, 1993).

Summary

If teachers in China and the U.S. are equally competent, and exert similar effort in mathematics instruction, yet Chinese students score higher on achievement tests, what other factors influence student achievement? What effect does the greater willingness of U.S. teachers to try new instructional methods have on student achievement? Similarly, what is the influence on student achievement of Chinese teachers' preference for more familiar methods? This study presents results indicating the many similarities exist between Chinese and U.S. teachers in relation to perceived competence, effort, and importance of assessments and student studying of material to student success in mathematics. More research is needed to further determine the impact of cross-national comparison of teacher instructional method preference, competence and effort on student mathematical achievement.

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