DOCUMENT RESUME

ED 433 233		SE 062 754

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TITLE	The Differences of Mathematics Achievement between American Children and Chinese Children.
PUB DATE	1997-03-00
NOTE	65p.; Master of Science Graduate Paper, Winona State University.
PUB TYPE	Reports - Research (143)
EDRS PRICE	MF01/PC03 Plus Postage.
DESCRIPTORS	Arithmetic; *Comparative Education; Computation; *Cross Cultural Studies; Foreign Countries; Grade 5; Homework; Intermediate Grades; *Mathematics Achievement; Mathematics Curriculum; *Mathematics Instruction
IDENTIFIERS	China; United States

ABSTRACT

This study compared intact beginning fifth grade classes in one of the districts in Shanghai, People's Republic of China to American Norms on the KeyMath-Revised: A Diagnostic Inventory of Essential Mathematics (KeyMath-R) and the Wide Range Achievement Test (WRAT-3). The review of literature contrasted the two cultures with regard to students, teachers, schools, parents, families, and esteem for mathematics, revealing that American students did not study as hard as Chinese students, American teachers and schools did not show as much responsibility for students as their Chinese counterparts, and American parents did not spend as much time on their children as Chinese parents. American arithmetic norms on the two mathematics measures were used to examine the differences in mathematics calculation performance between samples of the two cultures. Statistically significant differences between the groups were found on both the KeyMath-R (p.001) and the WRAT-3 (p.01). Chinese students scored markedly higher in mathematics calculation skills. Comparison of Chinese children's scores revealed achievement on the KeyMath-R at the 93rd U.S. percentile compared to the U.S. 50th percentile, more than one standard deviation higher than American students. In the WRAT, Chinese standard scores were advanced by 1-2 grades and by 1-2 years of age equivalence. No differences were shown between Chinese boys and girls in the tests. (Author/CCM)

THE DIFFERENCES OF MATHEMATICS ACHIEVEMENT BETWEEN AMERICAN CHILDREN AND CHINESE CHILDREN

by

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A graduate paper submitted to the Department of Special Education in partial fulfillment of the requirement for the degree of Master of Science in Education (Learning Disabilities Concentration)

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March 1997

ABSTRACT:

This study compared intact beginning fifth-grade classes in one of the districts in Shanghai, People's Republic of China, to American Norms on the KeyMath-Revised: A Diagnostic Inventory of Essential Mathematics (KeyMath-R) and the Wide Range Achievement Test (WRAT-3).

The review of literature contrasted the two cultures in regard to students, teachers, schools, parents, families, and esteem for mathematics in the two cultures, revealing that American students did not study as hard as Chinese students; American teachers and schools did not show as much responsibility for students as Chinese counterparts; American parents did not spend so much time on their children as Chinese parents.

American arithmetic norms on the two mathematics measures (the KeyMath-R and WRAT-3) were used in order to examine the differences in mathematics calculation performance between samples of the two cultures. Statistically significant differences between the groups were found on both the KeyMath-R (p.001) and the WRAT-3 (p.01). Chinese students scored markedly higher in mathematics calculation skills.

Comparison of Chinese children's scores revealed achievement on the KeyMath-R at the 93rd U.S. percentile compared to the U.S. 50th percentile, more than one standard deviation higher than American students. In the WRAT, Chinese standard scores were advanced by 1-2 grade and by 1-2 years of age equivalent. No differences were shown between Chinese boys and girls in the tests.

It was recommended that American teachers should patiently spend more time on students academic achievement, treating students as their own children, before referring them to special education. Mathematics curriculum should be re-constructed for good

quality teaching processes. Textbooks should be unified throughout each district and should be changed every three years in order for teachers to advance themselves through the idea that "Teaching is also learning." A teacher should teach one subject (math) instead of all subjects. If students are not successful at a particular level, they must repeat the course until they succeed. They should master the four Operations by the end of the fourth grade. American children should be educated to strive hard in mathematics. Parents should invest more time or money in children's education, including after school tutoring by volunteers or professionals and parents coaching and helping math homework completion.

Chapter 1

Introduction and Statement of the Problem

The purpose of this study was to compare samples of Chinese fifth-grade math classes to American arithmetic calculation norms on two mathematics measures, the KeyMath-R (a Diagnostic Inventory of Essential Mathematics - Revised, Connolly, 1988) and WRAT-3 (Wide Range Achievement Test, 3rd edition, Wilkinson, 1993) in order to examine mathematics calculation performance differences between samples from the two cultures.

In the 1980s and early in the 1990s, researchers studied the differences in mathematics achievement of American children and Chinese children (Stigler, Lee, Lucker and Stevenson, 1982; Stevenson, Lee and Stigler, 1986; Stigler, Lee and Stevenson, 1987; Chen and Stevenson, 1989; Stevenson, Lee, Chen, Stigler, Fan and Ge, 1990; Stevenson, Chen and Lee, 1993; Chen and Stevenson, 1995). Stories arousing concern regarding American children's weaknesses in mathematics have since appeared in the press.

These researchers found that "Deficiencies among American children appear as early as kindergarten and persist throughout elementary school" (Stigler, 1990, p.1053). Chen and Stevenson (1989) pointed out that "The American children consistently received significantly lower average scores on the mathematics tests than the Chinese and Japanese children in first, third, and fifth grades" (p.554). For example, Stevenson, et al., (1990) reported that:

> On the computation test, only 2.2% of the Chinese first graders and 1.4% of the Chinese fifth graders obtained a score at or below the mean for their American counterparts. That is to say, of 100 the Beijing children, roughly 98 children were above average according to the Chicago data. ... In the word-problems test, for example, only 2.6% of the Chinese first graders and 10% of the Chinese fifth graders obtained a score at or below the American means. (p.1058)

These differences in abilities continue to be a concern to American educators and periodic re-examination and discussion of this situation is extremely important.

Since Chinese children had consistently high levels of academic achievement in mathematics, researchers wanted to know how Chinese children studied mathematics and why Chinese children performed better in mathematics than American children. These researchers thought that American children showed poor performance in mathematics partly because of low motivation for developing more attention to mathematics. Stevenson, et al., (1990) observed: "There is a growing literature suggesting that children's achievement is related to the attitudes held by the children, their parents, and teachers. This has been found to be true in studies of children within the United States" (p.1054). In such a case, considerable evidence suggests that Americans emphasize achievement in schools less than the Chinese (Hess, Chang and McDevitt, 1987). Low standards held by American parents for academic achievement and lower interest in teaching mathematics by American teachers appear to contribute to American children's poor performance (Stevenson, et al., 1990).

Chinese children, on the other hand, were found to have studied conscientiously. They spent more time on study and did more homework than American children. Chinese children were assigned homework "four times as much as American children " (Chen and Stevenson, 1989). Chinese children had high motivation and showed positive attitudes towards mathematics study. Chinese parents were more willing to help children complete their assignments than American parents, although their education level was a little lower than that of American parents. Chinese teachers and schools were more responsible to their students than were American teachers and schools. When students, for example, were poor at academics (i.e., lower test scores, lagging behind others in study), teachers were worried and spent more time helping the students catch up with the rest. Some teachers even sacrificed their spare time to make up lessons for those who lagged behind others in study. School officials praised those teachers who were more responsible to their students.

The review of literature explored other reported causes for the Chinese children's higher achievement in mathematics as compared with American children. This superiority may involve several important factors: 1) Chinese children's more positive attitudes toward mathematics than American children; 2) active involvement of Chinese parents in assisting their children with homework; 3) Chinese teachers and schools being more responsible to their Chinese students than American teachers and schools; 4) Chinese parents having a long tradition of reverence for school achievement more than did American parents; and 5) Chinese parents believing that knowledge is acquired through effort and even innate geniuses need hard work for success, and everyone can succeed as long as he or she can study hard. There is no such thing as special education in China now for students with learning disabilities (LD) and emotional behavior disorders (EBD) as in the United States. Chinese teachers paid much greater attention to the first and second graders' education, since a solid foundation laid for first graders built the foundation for Chinese children to continue successfully in the upper grades. These parents' and teachers' attitudes must influence and contribute to the success of Chinese children in mathematics performance.

This paper used the data collected from the tests (WRAT-3 and KeyMath-R) to show Chinese students scores and proficiency levels in arithmetic calculation compared with American norms. Finally the paper provided some suggestions on how American children would perform better in mathematics.

Null Hypothesis

Two samples of Chinese students in fifth grade math classes were tested using the KeyMath-R and WRAT-3 achievement tests to test for no significant differences in average achievement in mathematics calculation in comparison to American students in the fifth grade.

Statistical Analysis

A modified t-test procedure tested differences in the means between the Chinese samples and American norms. A probability level of .05 was the significance level for rejection of hypotheses of no difference.

Research Questions

Why were Chinese children better in mathematics achievement than American children?

Review of Literature

The purpose of the study was to measure arithmetic calculation differences between American and Chinese children in the fifth grade. In support of the main research question above, the review of literature included the following subquestions:

1. Did Chinese children have higher motivation?
2. How did Chinese culture and family influence their children?
3. Why did Chinese children study hard?
4. Were Chinese children taught mathematics earlier?
5. Did Chinese parents have more involvement in helping their children than American parents?
6. Did Chinese teachers show more responsibilities to their students than American teachers?
7. How did Chinese teachers cooperate with parents?
8. How did Chinese teachers teach their students?

9. How did the "one child" family policy impact Chinese children in their studies?
10. Did Chinese children receive full support from their family members?
11. To what extent did Chinese children have competition among peers and schools?

The review of literature provided background information concerning these questions for the study of differences in mathematics between American children and Chinese children.

The literature reviewed was obtained from sources of the files of ERIC, GE, EAI, and BIP, etc., in the Winona State University Library. The Internet was also used as a source for background readings and topic definition. The topical search categories below corresponded with the previous research questions:

1. Attitude and motivation
2. China's only child policy
3. Homework
4. Competition among children, teachers, schools
5. Cooperation between teachers and parents
6. Family setting
7. Children's leisure time
8. Special education in China
9. Chinese fifth-grade mathematics curriculum and syllabus

Delimitations

The writer restricted the study as follows:

Literature review: The review of the literature focused mainly on studies revealing that Chinese children had better mathematics achievement than American children over a seventeen year period, from 1980 through 1996.

Participants: Only Chinese students were tested. Participants in the study were 94 students in the fifth-grade math classes in one of the districts in Shanghai, the People's Republic of China. American students were involved in the norms previously established by the KeyMath-R (1988) and WRAT-3 (1993) tests.

Definitions of Terms

BIP means Books in Print.

Chinese children refers to Chinese children from age 3 through 18.

Chinese fifth-grade math classes refers to students who were studying then at fifth grade (at fifth grade one month old, first semester, September-January 25 of 1996-1997 academic year) in one of the school districts in Shanghai, PRC.

Chinese students refers to students from k-12. Typically they were 10 years and 6 months old at the time of the test. Chinese children began the first grade at age 6 (but, some were 5.5 years old).

Deng Xiaping, 92 years old now, was former Chairman of the Communist Party of China. He initiated Chinese open-door strategies in 1979 and is held high esteem among the Chinese people and the world over.

EAI means Expanded Academic Index.

GE means General Magazine and Newspapers.

Homework refers to what was assigned by the teachers as well as by parents to be completed by children after school.

KeyMath-R is a Diagnostic Inventory of Essential Mathematics, Revised (Connolly, 1988), which has 13 subtests and 258 test items that cover three areas: 1) basic concepts, 2) operations, and 3) applications. It is designed for the elementary and middle-level grades from kindergarten through grade 9.

Only the operations subtests in addition, subtraction, multiplication, and division were administered.

Learning disabilities (LD) means "a disorder in one or more of the basic psychological processes involved in understanding or using language, spoken or written, which may manifest itself in an imperfect ability to listen, think, speak, read, write, spell or do mathematical calculation. The term includes such conditions as perceptual handicaps, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia. The term does not include children who have learning problems which are primarily the result of visual, hearing, or motor handicaps, of mental retardation, of emotional disturbance, or of environmental, cultural, or economic disadvantage." (Federal Register, 1977)

PRC means the People's Republic of China.

Special education refers to "specifically designed instruction that meets the unusual needs" of a child with a disability (Hallahan, 1991).

The only child refers to a child by a Chinese couple limited to a single child in the family because of the 1979 Chinese government policy in order to control Chinese population (China has 1.3 billion people now).

WRAT-3 means Wide Range Achievement Test, third edition (Wilkinson, 1993). It can be used to test individuals aged 5-75. Only the arithmetic subtest was used.

Value of the Study

To some extent this study was a replication and verification of previous comparisons of Chinese and American math performance in school. This study described operationally the differences found between samples so that a better understanding of differences in specific skills was made. There may also be implications for studying Oriental children in the United States in relation to special education assessment in mathematics.

Chapter 2

Review of the Literature

This review covered the literature for American and Chinese parents' and children's attitudes and motivation in education, Chinese children's competition in school achievement and American teachers' and Chinese teachers' attitudes toward children's study.

Attitude and Motivation

In the Chinese people's eyes, motivation and attitudes regarding education and study were of great importance for children. "Why do you study?" "For whom do you study?" "How do you study?" These were the frequently asked questions among Chinese people who have been influenced by Confucian doctrines and philosophy for two thousand and five hundred years. Chinese people have always regarded the "study hard" principle as the first step to academic success. Some popular sayings derived from Confucian doctrines and Chinese beliefs are, "One cannot succeed without effort," and "Being diligent in study means devoting one's effort to it for a long time." When Chinese children began the first day school, they were filled with such philosophic aphorisms as, "Knowledge is acquired, not innate," "Be diligent in study and become a man of ability," "Study well and make progress every day," and "Innate geniuses also need hard work."

Effort was extraordinarily important according to Chen, Chuansheng and Stevenson. (1995), who observed that:

> Confucian doctrine, which has had a pervasive influence in East Asia, emphasizes the malleability of human behavior and the importance of effort as the route to accomplishment. Chinese and Japanese elementary school students and their parents, presumably influenced by this doctrine, place greater emphasis on the role of effort than do their U.S. counterparts. (p.1222)

The respect for scholarly attainment parallels a high regard for effort: "Hard work offers the major route to accomplishment and competence" (Chang, 1985). The Chinese saying, *shao zhuang bu nu li, lao da tu shang bei*, means "If one does not exert oneself in youth, one will regret it in old age." Such tenets extolled the virtue of effort in pursuit of learning better through hard work or diligent study. These parent and teacher attitudes toward diligent study affected children's motivation in academic activities. Chinese parents usually encouraged their children to study hard, and never to be conceited even if they made some progress. Chinese parents held that the enemies of study were laziness. Stevenson, Chen & Lee (1993) concluded that "Chinese parents stressed the importance of hard work as the route to success, while American mothers emphasized the importance of innate ability." Kutner (1996) pointed out that "[American] children look to their parents for cues as to how they should respond when they're frustrated by a math problem. The parent's attitude was often much more important than the ability to crunch numbers." Additionally, Chinese people hold that those who learn most are respected most. Obviously, when each family is limited to one child, Chinese parents set high expectations of the one child in his or her study, and Chinese children have recently produced much better academic achievement than fifteen years ago.

In a study contrasting the two cultures, children of both countries were asked to tell what were the most important factors that influenced their performance in mathematics. Given four factors: a good teacher, innate intelligence, home environment, and studying hard, children of both countries chose different factors. Chen and Stevenson (1995) reported:

> Fewer than 20% of the students in any of the groups chose "innate intelligence" or " home environment." ... the majority of the Chinese and Japanese students chose "studying hard," whereas the predominant choice of both the Asian-American and Caucasian-American groups was "having a good teacher." (p.1222)

Besides having a good teacher, "confidence, risk-taking and feeling in control are important in doing well in math" (Kutner, 1996), in addition to the attitude of "studying hard." Thus, Chinese children's good attitudes and high motivation toward study appeared to play an essential role in their superior mathematics achievement.

The Only Child

Since 1979, Chinese couples throughout the country have been allowed to have only one child in their families. Because of that policy, Chinese parents were determined to have the best possible child. Parents paid much attention to all aspects of their child in order for their only child to learn well even before going to primary school.

These parents all wished their child to possess special talents, and to become a gifted child and a famous scientist. These parents personally attended to their child's early intellectual development. Doris (1982) emphasized that "Parents are indeed a source of educational support for children. The practice of home teaching has merit, and parents can strive to provide a household learning environment conducive to their child's education." Some Chinese children began early to study basic arithmetic taught by their parents at home, so they became good at math. Many parents found from their teaching that "understanding mathematical concepts helps a child develop simple computational skills" (Gilley, 1980).

Chinese parents wished their only child to not only achieve well academically, but they also had an intense desire to foster their child's artistic talents. Epstein (1991) stated:

> From its first days, the infant's progress is watched with anxiety by the parents. Nearly all the parents were able to recall the exact age at which the child had said its first words and had taken its first steps. Parents are quick to seek advice or consult books on child care and development if they think they detect anything abnormal. There is a considerable audience for new magazines directed at the parents of young children and for radio and television programs that give advice on child care. Toddlers are taught to recite *Tang* poetry. (p.47)

Chinese parents hold that "Whoever can recite 300 *Tang* poems will be able to write anything even if he or she couldn't write at first." These Chinese children were "far too young to understand the lines they were uttering, but this did nothing to dampen the enthusiasm of their proud parents" (Epstein, 1991).

Chinese children attended good kindergartens and quality schools at high cost. "Their teachers tend to be well trained and to be interested in child development theory. The kindergarten offers a useful preparation for school ... The subjects taught include language, arithmetic, general knowledge, music, art and physical education" (Epstein, 1991). Those kids stayed two or three years (from age three to age six) in the kindergartens before going to school. Therefore, most of the children received a good education there and later on excelled in school. According to U.S scholarly research, they thought that "If given more intellectual investment, these only children will own higher IQs"(World Journal, 1996).

"Chinese parents spend 25%-50% of their joint incomes directly on their single child" (Epstein, 1991), buying textbooks, toys and other necessities for their children. The intellectual resources of the Chinese only child were tapped earlier than children of the same age two decades ago. The whole family supported the only child who had the complete attention of six adults: two parents and four grandparents. These only children grew well. They knew a lot, even at age three, and were bright and were quick to learn. Their language was well developed and they were articulate and ready to speak. So far as mathematics is concerned, some children were able to count from 1 to 50 and did addition and subtraction with numbers up to 20 at the age of three or four. Some were able to write and read 100 Chinese characters. Today's young parents were children during the Cultural Revolution (1966-1976), so some parents managed to make up for the time they lost in the Cultural Revolution. As a result, Chinese parents were determined that their children should make full use of what they saw as a much better opportunity than was offered to the parents. Parents concentrated their whole attention on their only child, and they felt that everything depended on the actions of the parent. Thus the only child policy pushes forward the younger generation in education and that may be a major reason why Chinese children performed better in mathematics achievement than American children.

In addition to the young children's early academic learning, Chinese home education was very important for any child in order to have good moral character and sense of responsibility to society and family as well.

Homework

Chinese parents believe that children who do not do homework after school are not good children. The Chinese have long respected academic accomplishments, and doing homework is one of the ways that can help children consolidate what they have studied in school and develop a diligent personality, along with fostering children's self-image and the ability to be independent. Therefore, homework is regarded as being an important part of academic accomplishment by Chinese society. Chen, Chuansheng and Stevenson (1989) pointed out that:

> Academic success is strongly emphasized in Chinese society, and parents and teachers apparently perceive the additional practice and review provided by homework as a useful contribution to children's success at school. American teachers do not place a high value on the contribution of homework to the learning process and relegate it to a low position in the hierarchy of activities involved in children's success in school. American children do not appear to enjoy doing homework, and their mothers believe they must intercede in order to see that the children complete their homework. These attitudes are in sharp contrast with those of their Chinese counterparts, who perceive homework to be important, useful, and enjoyable. Homework is the primary out-of-school activity for Chinese children, and they devote long hours each day to their homework. (p.560)

According to the article, "Pupils' Workload Calls for a Break" in *Beijing Review* (March 16-22, 1992), "The average work for a pupil in one night of his last year [1991] of primary school includes a composition of 300-400 words, reviewing and retelling a new lesson, and a 300-character practice of calligraphy, in addition to working out 24 arithmetic problems. These mean no less than five hours of hard work." A Chinese child spent five hours on homework every day, whereas American children might spend five hours watching TV every day. In the first grade, especially in the second semester of the grade, arithmetic teachers usually assigned homework to their kids, at least 20 items of arithmetic questions (*problems* used in U.S.) for consolidating what they studied in school. Thus by the end of the first grade, students were able to do addition and subtraction with the numbers within 100 (also see the curriculum in Appendix 4). Such "cramming" education (reputed by the Chinese people) was geared to the situation that "The majority of urban families now have only one child, who is thereby burdened with the expectations of the entire family. Most parents, eager to have their children succeed, set high standards for their school work" (*Beijing Review*, Dec. 28, 1992).

Therefore, if a Chinese teacher did not assign homework to his or her pupils, Chinese parents would complain of the teacher being lazy or irresponsible, and the teacher was considered an idle teacher. It is said that in 1994, a group of newly arrived Chinese immigrants settled down in Seattle, Washington. Their children studied in an elementary school for a year, but the teachers in the school seldom assigned their pupils homework. Because of that perceived deficiency in the school, a group of Chinese parents complained that these teachers were not giving homework to their children and they wrote a request to the school board and to a newspaper as well.

How much children liked homework was positively related to how much they liked school. Chinese children said that they did homework because they loved it, as well as

> because they wanted to avoid their teacher's punishment. The motivation of Chinese children is especially interesting. Despite the large amounts of homework they were assigned, they did not develop a negative attitude about homework. American and Japanese children were pragmatic. They spent as much time on homework as was necessary and gave no indication of enjoying what they did. (Chen and Stevenson, 1989).

Doing homework was part of Chinese children's school life. They enjoyed doing it and their parents helped them with their homework, because doing homework could help children reinforce the materials presented in class. That is why (Chen and Stevenson, 1989) "Chinese teachers assigned more than twice as much homework as Japanese teachers and four times as much as American teachers" (p. 556).

Competition

Competition among children. "Whoever excels in mathematics, physics, and chemistry, will be successful under heaven," was a belief which prevailed among the Chinese people in the past few decades. Chinese parents longed for their children to become successful persons for society and, more specifically speaking, on behalf of their families. Because of this expectation, many Chinese children paid more attention to these "success" subjects in school than to other subjects. This belief is one of the reasons why Chinese children studied hard and, as a result, were good at mathematics, and especially why Chinese parents paid more attention in their only child's education. As is known to all, China is a still a developing poor country with a huge population of 1.3 billion. There are still many regions in which the economy is not developed very well, and many people want to get rid of the long tradition of manually-dominated labor. Chinese parents do not want their children to suffer what their parents and grandparents suffered because of lack of schooling. Therefore, competition among peers was also prevalent. No one wanted to lag behind others academically. Chinese parents wanted their children to compete for good jobs with decent salaries in the future. Especially in the past eighteen years, since the open-door policy initiated by Deng Xiaoping, Chinese parents have come to know the importance of children's education. If the student can compete for and complete a college or university education, he or she can find a good job. Therefore, academic competition is very intense among Chinese children now. It is no wonder that "The rigorous competition to enter university often starts in primary school. People with university diplomas usually get better jobs and have a good chance of promotion "(*Beijing Review*, March 16-22, 1992). Not all the students who can graduate from high school will be able to enter college or university. Only 50 or 60% of them are able to go to college or university through examination. This college entrance competition is also one of the reasons why Chinese children studied so hard and were good at mathematics.

Competition among teachers and schools. Besides competition among children, competition was also present among teachers and schools. All teachers wanted their classes to get high academic test scores. In China test scores were the main criterion to measure a teacher's level of instruction and the status of the school as well. If the class got high scores on tests, the teacher would feel honored, and as a result, the teacher may get a bonus or promotion. Ridley (1973) pointed out that "In China, the examination system has provided a route to social, political, and economic mobility for more than a thousand years." Therefore, teachers used their spare time (without being paid) to help their students do enrichment activities, coached them, or made up their lessons which students missed owing to sick leave or the like, in order to improve students' academic achievement. Teachers also worked hard to improve their teaching quality. Teachers were not good teachers in the Chinese people's eyes if they were not able to teach well, even if they held a Ph.D. degree.

Moreover, Chinese teachers learned from each other. They sat in each other's class, observing each other's teaching methods, teaching skills, and students' reactions (behaviors) in order to improve their teaching quality in their own classrooms. This observing of each other's classes became the order of the day. Chinese teachers usually conducted direct instruction in their classrooms and had to use mandarin Chinese in their classrooms, beginning in the first grade (but mandarin Chinese was also taught in kindergarten). The compulsory use of mandarin Chinese helped students in laying a good foundation for the future mastery of Chinese language in upper grades and, most importantly, helped students communicate people from the different parts of China, whereas in the United States teachers often used regional English (or dialects) to conduct lessons instead of using Standard American English. It was also Chinese teachers' responsibility to help children understand what was presented in class. Some teachers sacrificed their spare time to organize children's group study after school without being paid. It is also noted that in China there were no teacher aides. The classroom teacher was in charge of everything.

Schools also sought to raise their academic status to high levels. Therefore, schools, by hook or by crook, endeavored to enhance their quality of education. The article, *Pupils' Workload Calls for a Break,* stated that:

> Some schools have advanced the start of classes from the normal eight o'clock to 7:15 am, or have cut the twice-a-week physical training class into one. The time saved is devoted to classroom work. Pupils' schoolbags are growing heavier with textbooks, guide books for examinations, review materials, test papers and other exercise materials. A primary school in Shanghai uses more than 80 different exercise books in addition to the many compiled by the school itself....
> All this has made many schools work hard in the hope that the children can succeed in exams for top middle schools, because the success rate weighs heavily with the reputation of a school" (*Beijing Review*, March 16-22, 1992).

Hess, Chang and McDevitt (1987) pointed out:

> In the PRC [People's Republic of China], the school takes the major responsibility for the student. Children in the PRC spend more time in school than do children in the United States. Beginning at the age of six years, the typical child in the PRC spends from 7:30 a.m. to 3:30 p.m. at schools, with 1 hr for lunch - 6 1/2 hr each day. In grade 4, the school day is usually 1 hr longer. After school, many children engage in study groups led by teachers. In addition, the school year includes about 280 days, in contrast to the 180-200 days in the United States. Additionally, the school is charged with responsibility for moral and physical development as well as for academic performance. (p.187)

Chinese students with longer stay in school (80-100 days more than American students each year) and doing more homework made it possible to surpass American students academically. Suppose Chinese students and American students studied the same level at the beginning of the first grade in primary school respectively, six years later, the Chinese students' level was the same as that of American students who finished 8th grade. This calculation means that Chinese students' longer stay in school, including the associated homework, made them receive far more schooling than American students. It was interesting to find that the level of Chinese middle school math textbooks was almost equivalent to that of American high school math textbooks.

In China a normal attendance for a student is 6 years in primary school, 3 years in middle school and 3 years in high school with the total of 12 years, but in 1996, the Chinese government changed a six-day school into a five-day school. However, Chinese students still stay longer in school (230 days) than American students (180-200 days) every year.

Because of the intense competition, children liked to choose quality schools to study in order to obtain good academic teaching and to produce great achievement. This selection of schools by students through examination increased the competition among Chinese schools.

Parents, Teachers and Schools

Parents. In China, parents play an important personal role in their child's education, because Chinese people have a long tradition of reverence for, and direct involvement in, education. Whether or not a child succeeds in education is directly related to the parents' attention, care, love, and help. Although Chinese parents received less education than American parents, they devoted most of their time to their children. Parents began to teach their kids simple symbolic algorithms during the preschool years and how to count up to 100 before the first grade. After the kid went to school, parents helped their kids with study even more. Chen and Stevenson (1989) stated that:

> How much time family members helped their child with homework each week was consistently higher for Chinese than for American families. Compared to American mothers, therefore, Chinese mothers were much more likely to assume that mothers generally provided large amounts of help for their children's academic work. Estimates were lowest for American fathers and highest for Chinese fathers. (p. 558)

Obviously, the only child received greater attention from family members, because, generally speaking, the only child had six adults: two parents and four grandparents. Additionally, Chinese parents were willing to invest in their children's education. In support of their child's education, Chinese parents bought anything with regard to his or her study, while "Their [American] parents, and their peers held lower standards for accomplishment and investment in education than did the Chinese" (Chen and Stevenson, 1995). As Chinese teachers assigned four times as much homework to their students as American teachers, this act added a great burden to Chinese parents to help their child complete the homework. Parents, instead of watching TV or doing other things in the evenings, stayed with their child until the homework was completed. Because of a large amount of academic work, the child was not allowed to do any house chores as long as (s)he was studying in order to insure good academic achievement.

"Although [Chinese] parents spend long working hours away from their small children, most of their leisure time is spent with them," according to Epstein (1991). Contrarily, "As American children grow older, parents appear to be less likely to provide the kinds of enriched out-of-school experiences that they did before the children entered first grade" (Stevenson, Chen and Lee , 1993).

Teachers and Schools. Chinese teachers and schools had more responsibility to a standard curriculum than American teachers and schools. Chinese teachers spent much more time on classroom teaching and coaching students after class to assure mastery of that curriculum, and some teachers even visited students and parents at weekends for academic purposes. They usually conducted direct teaching sessions to students and clear presentation of the curriculum was most valued. Stevenson, et al., (1990) pointed out that "In China, teachers follow a national curriculum. In our earlier research involving over 600 hours of observation in 20 fifth-grade American classrooms, we found that some American fifth-grade teachers devoted as much as 40% of their time to mathematics while others were never observed to be teaching mathematics." Moreover, "The Chinese teacher is, nonetheless, generally motivated and in many ways was industrious. Teacher absenteeism has been low and classroom work diligent " (The World Bank, 1986). In China, teachers usually taught their pupils according to the textbooks, step by step from easy to difficult. The teachers' clear presentation processes (including the board format, sequence, depth, handwriting, oral expression, etc.) was highly valued in Chinese classroom teaching, but in the U.S.A, "teachers ... often cover something of everything and little of any one thing" (Lawton, 1996).

Although "primary classes are large [30 - 45], the atmosphere is formal, and discipline is quite strict. Children are no longer required to sit with their hands clasped behind their backs as they were in the 1970s, but they sit in straight rows, stand up to answer the teacher, and recite much of what they are required to learn in unison. Most parents seem to believe that children need to complete a lot of homework if they are to do well enough at school to succeed in life" (Epstein, 1991). Chen and Stevenson (1989) explained that:

> Classroom structure and management differ greatly among the cultures. Asian classroom are more efficiently managed than the American classrooms; greater amounts of time are devoted to academic activities and to imparting information in Asian classrooms. Attentiveness on the part of children is high, transitions from one activity to another occupy little time, and children in Asian classrooms seldom engage in irrelevant activities during class periods. Much less time is devoted to small-group or individual activities where the teacher is in charge. This is in contrast with the organization of American schools, where children are more frequently divided into small groups or left to work on their own. (p. 554)

Teachers' attitudes toward subjects students studied, especially mathematics, must influence students' attitudes. Stevenson, et al., (1990) pointed out, "In general, mathematics held a lower status in the eyes of the American than of the Chinese teachers. Only 9% of the Chicago teachers but 34% of the Beijing teachers, mentioned mathematics as the most important of all the subjects they teach. Moreover, when asked what subject they most liked to teach, only 32% of the Chicago teachers, but 61% of the Beijing teachers, said mathematics. Chicago teachers preferred to teach language arts (46%)"

(p.1065). On the other hand, "the problems [of math anxiety in U.S.A.] arise when they start kindergarten. Elementary and preschool teachers usually receive far less training in how to teach mathematics than how to teach reading and writing" (Kutner, 1996).

In terms of the teachers' educational level, American teachers received much more education in the teachers' forces. Stevenson, et al., (1990) reported that "The educational level of the Chicago teachers was high; all held the bachelor's degree and 37% had received the master's degree. Most of the Chinese teachers (60%) had attended a teachers college for 2 or 3 years after graduating from high school; 37% had attended only high school." Despite the fact that Chinese teachers received lower educational level, they were able to teach their children mathematics better than American teachers, because Chinese teachers had their students in their heart, and showed more concern and felt more responsible to their students. Therefore, they tried their best to do the teaching well. Additionally, teachers of the same grades were gathered once a week to discuss students problems and work out solutions to the problems in order to improve students achievement. If the students always got lower scores than other students of the same grade in school, the teacher was first suspected of bad teaching or showing irresponsibility (not loyal to education) rather than the student problem(s). If that was true, he or she might be asked to leave the post temporarily and to participate in a teacher training class or change to another job.

Cooperation between Chinese parents and teachers. Above all, the cooperation between Chinese parents and teachers was excellent. Chinese teachers often kept in touch with their students' parents. They would come together to deal with children's problems arising from the children's studies. Chinese parents respected teachers, because "China has a long tradition of honoring and respecting teachers, and Chinese classics contain many passages praising the quality of the ideal teacher and the value of learning" (Price, 1970, and Shi Ming Hu and Seifman, E., 1987). The good cooperation between parents and teachers paved the way in students' learning and teachers' instruction as well. Teachers were strict with their pupils. A popular belief is that, "If teachers are not strict in their duty, they are idle teachers" (Price, 1970). It is interesting to note that Chinese children were afraid of their teachers, but not afraid of their parents, because in Chinese children's eyes, their teachers were the "authority" or "sage". This is because society gave more empowerment to teachers. Chinese believe that strict teachers can produce students of high quality. Teachers can do whatever they would like to do without school or parents permission as long as what they do is of benefit or of help to the development of students academic achievement, but teachers do not use physical punishment against students to help them improve academic achievement, but it is suspected that physical punishment may be used in some rural schools.

Family Setting

Family influences (such as divorce, death of either parent, parents' fight, parent's attitude in education, etc.) had much to do with the academic development of a child. That most of the Chinese children were good at mathematics probably had much to do with the integrity of the Chinese family. Stevenson, et al., (1990) reported that "Over 99% of the children in Beijing and 76% of the children in Chicago came from intact families. One or more grandparents were living with 50% of the Beijing families and with 10% of the Chicago families." Therefore, Chinese children also got more academic help from their family members than American children. Chinese parents were thoughtful parents. They were able to provide their child a quiet place to study at home. For example, parents stopped watching TV or doing other things in order not to disturb their child's study, because in China, the shortage of housing caused two or three generations to share the same living quarters.

Children's Leisure Time

Compared with American children, Chinese children had less leisure time or none at all. After school, Chinese children did homework. They seldom watched TV in the evening and were not allowed to watch TV, let alone hold after-school jobs or have "dates". Chinese children thus had a few after-school jobs (usually parents did not allow them to work), while "American children have after-school jobs (74%) and have 'dates' (over 85%)" (Steven, Chen and Lee, 1993). This situation might also be one of the reasons why American children could not devote themselves to study like Chinese children. In the Chinese people's eyes, the children's main task was very clear - to "study". Thus, there should be nothing to interfere with the children's study. Even if Chinese children had some leisure time, besides doing homework, they would go to a recreation study center or stay after school to receive teachers' additional teaching (such as coaching, make-up lessons, enrichment activities, etc.). The article "Children Abuse and Parental Expectations" in *Beijing Review* (December 28, 1996) stated that "Some children are not allowed to play after school. Besides the homework assigned by their teachers, they must also finish that assigned by their parents." Therefore, for Chinese children most leisure time was spent on study.

Concern for Mathematics Skills in America

American people were concerned about their students' low mathematics achievement. Stevenson, et al., (1990) pointed out that:

> Reports of American students' weaknesses in mathematics appear regularly in the popular and scientific press. Among these, the reports of cross-national studies of mathematics achievement have been especially disturbing. These studies document the profound underachievement in mathematics of American students compared to their peers in other countries. (p.1051)

Furthermore, Stanley, et al., (1994) pointed out that 82% of the American people wanted more emphasis to be given to mathematics because "mathematics, a subject in which our national performance is reputed to be dismal" (Bracey, 1994). Many factors or reasons explained why American students had low mathematics achievement. For example, teachers' unskillful teaching might affect students' learning. "Math and science curricula in the United States lack a coherent vision of how to educate students, compared with the coursework of other countries, ...The U.S. curriculum is a mile wide and an inch deep" (Lawton, 1996). In addition, "Deficiencies among American children appear as early as kindergarten and persist throughout elementary school" (Stevenson, et al., 1990). At the same time, "Number concepts are frequently taught as abstract manipulations of symbols rather than by using concrete manipulative, a right brain activity" (Creswell, 1988). In terms of the achievement, U.S Department of Education Region V (1997) stated that "In TIMSS (The Third International Math and Science Study), the U. S. average score is below the international average and only 5% of U.S. eight grade students score in the top 10% internationally."

Additionally, American students did not spend much time on mathematics study, including doing mathematics homework. American parents did not involve themselves much in their children's studies. All these factors contributed to American students' underachievement in mathematics. Actually, American children "possess strengths in mathematics, such as greater understanding of mathematical operations, ability to estimate outcomes, and skill in applying number concepts ..." (Stevenson, et al., 1990). Therefore, American students have the abilities to study mathematics and to develop proficiencies.

Special Education in China

In China special education is not so widespread as in the United States, although there are special schools for the blind and the deaf. China should learn from the United

States in how to implement special education throughout the country. According to Deng Pofang, Chairman of the Association of the Handicapped of the People's Republic of China, "One out of five families has a person with physical disability. The handicapped and the disabled account for more than half of the population of the poor people in China; 50% of the handicapped and the disabled have no work. Their average income accounts only for 50% of the average income of an ordinary person; 48% of them have not been married; 68% of them are half literate or illiterate; 70% of them are supported by their family members or relatives. Quite a few handicapped and disabled children have no chance to go to school" (*People's Daily*, Overseas Edition, March 24, 1995). Literacy and reading problems were therefore concerns of the Chinese educational authorities, but special services were generally unavailable. Special tutoring for conditions such as learning disabilities was usually handled within the family. Students with learning disabilities or the like who were not successful in academic achievement would stay in school for only 9 years (because of the 9 years compulsory education policy). Normal school attendance is 12 years (1-12). Special remedial services are provided by repeating a grade and some children repeat the same grade for several years during the nine years study owing to their poor academic performance in primary school. Generally, grades are repeated at the primary level. Thus, some children are able to go up level after they have repeated grades one or two years.

The Summary of the Review

Stevenson, et al., (1993) initiated a comparative study of American, Japanese, and Chinese elementary school students in Minneapolis, Sendai (Japan), and Taipei (Taiwan) in 1980. The results showed that Chinese and Japanese first and fifth graders greatly surpassed their American counterparts in mathematics and that Chinese children were more capable readers than Americans. The low levels of achievement found in Minneapolis were especially worrisome. Stevenson, et al., (1993) added, "because Minnesota students rank high among the states in mathematics achievement, and Minnesota has the highest percentage in the nation of students graduating from high school." Four years later, Stevenson and others returned to the same schools and followed up the first graders who were now fifth graders. To their surprise, no obvious improvement took place in the mathematics achievement of the fifth graders in the past four years, whereas cross-cultural differences were as great in 1984 as they had been in 1980. Bracey (1996) pointed out in his article, *The Sixth Bracey Report on the Condition of Public School*, Phi Delta 1996, that "Asian students still score higher on tests than American students, no question."

All differences were also highly significant when comparisons were made between the scores of American children and the sample of Chinese children, those children who had received the same amount of schooling as the American children at the time of testing. Stevenson, et al (1990) reported that "This was true for the group test of computation ... and the geometry test at fifth grade, ... p's < .001. It was also true for the individually administered tests selected for the replication study (word problems, number concepts, visualization, measurement, and the speed tests), ... p's < .001." According to the report by Stevenson, et al., (1990), the summary of the test results of the sample was made of the fifth grade as follows:

MEAN SCORES (+SD) ON THE MATHEMATICS TEST FOR GRADE 5

	Beijing	Chicago	Total Possible scores
Fifth grade:	n = 999	n = 831	
Computation	57.5 (4.8)	45.7 (6.6)	78
Word problems	18.3 (3.8)	12.7 (3.8)	28
Mathematical operations	13.4 (2.1)	8.9 (2.7)	21
Number concepts	28.2 (3.1)	21.1 (5.6)	34
Measurement	10.2 (1.7)	8.8 (1.8)	13
Visualization	10.7 (2.0)	10.5 (1.8)	15
Speed A	52.6 (11.3)	33.2 (11.7)	81
Speed B	18.1 (6.0)	7.9 (4.7)	72
Speed C	9.8 (4.3)	4.3 (1.7)	17

(p.1058)

The above table was part of the original table made by Stevenson, et al., who concluded that "It is evident that the scores of Chinese children exceeded those of Chicago children in nearly every comparison" (p.1058). But there was one exception in which the difference between the means for Chicago and Beijing children was not significant. That is, in visualization American children scored 10.5 and Chinese children scored 10.7. From the above table, it is shown that Chinese fifth graders with the score 52.6 in Speed Test A "solved half again as many single-digit problems as the American fifth graders" (p.1057) with the score 33.2, "and on the more difficult tests" (Speed Test B, two-digit addition problems and Speed C, problems involving multiplying a two-digit by a one-digit number), Chinese students scores were double the U.S. score, yet these children of two cultures "received the same amount of schooling...at the same time of testing" (Stevenson, et al., 1990).

All the information gleaned in the study indicated that American children did not develop in mathematics achievement as well as Chinese children. Stevenson, et al., (1990) reported that:

> The results provide a bleak picture of American children's understanding of mathematics. There were almost no areas in which the Chicago children performed

> as well as the children in Beijing. The deficiencies of American children were pervasive. In nearly all comparison, scores of the American children were significantly below those of the Chinese children" (p.1057).

Besides the deficiencies of mathematics, American children did not solve problems as effectively and rapidly as Chinese children. Stevenson, et al. (1990) summarized:

> In the first grade, they solved nearly three times as many single-digit addition problems as the American children. Chinese fifth graders solved half again as many single-digit problems as the American fifth graders, and on the more difficult tests, they solved twice as many problems....On the computation test, only 2.2% of the Chinese first graders and 1.4% of the Chinese fifth graders obtained a score at or below the mean for their American counterparts. That is to say, of 100 the Beijing children, roughly 98 children were above average according to the Chicago data. ... In the word-problems test, for example, only 2.6% of the Chinese first graders and 10% of the Chinese fifth graders obtained a score at or below the American means. (pp. 1057-1058)

Chen and Stevenson (1989) explained that "A common explanation of the poor performance of American children in cross cultural comparisons of academic achievement is that American children spent little time in study. American children spend fewer hours in school and devote less time in school and after school to academic activities than do children in many other countries." As mentioned before, Chinese children did four times as much homework as American children. In addition to that, classroom structure and management differed greatly among the cultures. Chinese classrooms were more efficiently managed than the American classrooms. Chen, et al., (1989) pointed out that:

> Greater amounts of time are devoted to academic activities and to imparting information in Asian classrooms. Attentiveness on the part of children is high, transitions from on activity to another occupy little time, and children in Asian classrooms seldom engage in irrelevant activities during class periods. Much less time is devoted to small-group or individual activities in Asian classroom; most of the class time is devoted to activities where the teacher is in charge. This is in contrast with the organization of American schools, where children are more frequently divided into small groups or left to work on their own. (p.554).

Chinese teachers were also more hardworking than American teachers. Stevenson, et al. (1990) observed that "The common observation is that teachers are spirited and energetic and the children are dedicated and enthusiastic. Visitors have been impressed by the apparent high levels of academic and social competence of Chinese children" (p. 1053). In terms of the educational level, Americans teachers were high and "all held the bachelor's degrees and 37% had received the master's degree. Most of the Chinese teachers (60%) had attended a teachers college for 2 or 3 years after graduating from high school; 37% had attended only high school " (Stevenson, et al., 1990).

Another critical factor in influencing children's attitudes about mathematics was the teachers' emphasis of the importance of mathematics, whereas American teachers de-emphasized the importance of mathematics. "Children's motivation to work hard in school is influenced by the attitudes and evaluations of their parents and teachers" and "The ability of teachers to provide effective instruction in mathematics may be diminished when mathematics is a topic for which they express little fondness and profess modest skill" (Stevenson, et al, 1990). Kutner (1996) stated that [American] elementary and preschool teachers usually receive far less training in how to teach mathematics than how to teach reading and writing."

It was also found that the only child policy forced Chinese children into studying diligently and having fierce competition among themselves. American children, on the other hand, expressed less positive attitude and less motivation in mathematics study than Chinese children, who spent most of the leisure time, in addition to the time they spent in school, on homework much more than American children, so Chinese students were more sleep-deprived. Bracey (1996) mentioned that a Korean girl studied 80 hours a week, who "has heard about American high school students hanging out at malls, joining activities like the track team or the yearbook, and even dating, but there is little time here for that" (p.129). Chinese parents and teachers had better cooperation in dealing with children's study and taught math earlier; especially after the one child family policy was implemented in 1979, Chinese parents paid much attention to early child education and continued up to the time when they graduated from college or university. As soon as babies began to speak, they were taught very basic math, such as counting, reading pictures, recognizing basic figures. When they grew a little older, say, three years old, they were taught simple basic addition, then subtraction. This was taught by family members at home as well as at kindergarten. When they began to go to school at age 6 (some at 5.5 or younger), they had mastered some basic arithmetic. They were ready to learn before going to school, whereas recent research in the United States, Japan, and Taiwan (Stevenson, et al., 1990) indicated that "Deficiencies among American children appear as early as kindergarten and persist throughout elementary school" (p.1053); also Chinese parents discovered their child's problems early and pushed their child in order to make up deficiencies.

Many examples showed that Chinese children studied hard because of the unique culture traits, achievement behavior, educational environment, the influences of family, peers, schools, and the like. All these contributed to Chinese students achieving better academic performance in mathematics.

"Clumsy birds should start to fly early." is a Chinese maxim for early identification and remedial action. Some American parents by contrast are aided and abetted in a policy of wait and see, or "don't create a self-fulfilling prophecy" by pediatricians, day care workers, teachers and school administrators. This wait and see attitude has become official policy in some districts where formal assessment is delayed until third or fourth grade for fear of stigmatizing children with scores which reflect poor performance. Under such a policy needed help often comes years too late. Other districts make efforts to identify problems early, but no consistent policy applies to all U.S. districts.

The contrasting attitudes and practices of the two cultures appear to produce markedly different results in mathematics abilities.

Chapter 3

Procedures

The study was designed to compare samples of Chinese fifth-grade math classes to American arithmetic norms on two mathematics measures, the KeyMath-R and WRAT-3 in order to examine differences in mathematics calculation performance between the two cultures. To obtain information for answering the research questions set forth in this study, the following steps were taken: Chinese fifth-grade math classes took the KeyMath-R and WRAT-3 tests in October 1996. Essentially the students were showing their skill level following math instruction in fourth grade. Their average age at testing was 10 years and 6 months.

Materials

KeyMath-R (a Diagnostic Inventory of Essential Mathematics - Revised, Connolly, 1988) Form A and WRAT-3 (Wide Range Achievement Test, 3rd edition, Wilkinson, 1993) Tan Form were used to test the Chinese fifth graders in Shanghai, the People's Republic of China (PRC).

KeyMath-R, constructed by Austin J. Connolly and published by American Guidance Service (AGS) in 1988, is a diagnostic inventory of essential mathematics. It is an individually administered instrument, the purpose of which is "to provide a comprehensive assessment of a student's understanding and application of important mathematics concepts and skills" (p.1). There are two forms of the KeyMath-R, Form A and Form B, each of which contains 13 subtests that constitute three major areas of mathematics with 258 test items. These three areas are 1) **basic concepts**, 2) **operations** and 3) **applications**. The KeyMath-R is designed for "the elementary and middle-level grades from kindergarten through grade 9" (p.1).

All subtests except Mental Computation are untimed. Reading skills are not needed, because the examiner reads all questions and problems to the student. If a student has a limited English proficiency, he/she has a problem for testing. On most of the KeyMath-R subtests, students respond **orally**, but writing is required on four subtests of Operations. The three major areas and their subtests are:

Basic Concepts

1) **Numeration** -- 24 items evaluate a student's understanding of the number system (numbers 0-999), including the skills in counting, reading numbers, sequencing numbers, place value, and rounding.

2) **Rational Numbers** -- 18 items evaluate a student's ability to identify, order, and compare fractions, decimals and percents.

3) **Geometry** -- 24 items evaluate a student's understanding of spatial/attribute relations, two-dimensional shapes, coordinates/transformations, and three-dimensional shapes.

Operations

4) **Addition** -- 18 items include models and basic facts, algorithms: whole numbers, and adding rational numbers. The student writes the answers for items 7 through 18.

5) **Subtraction** -- 18 items include models and facts, algorithms: whole numbers, and subtracting rational numbers. The student write the answers for items 7 through 18.

6) **Multiplication** -- 18 items include models and basic facts, algorithms: whole numbers, and multiplying rational numbers. Again, the student writes the answers for items 7 through 18.

7) **Division** --18 items include models and basic

facts, algorithms: whole numbers, and dividing rational numbers. The student writes the answers for items 7 through 18.

8) **Mental Computation** -- 18 items include

computations, whole numbers, and rational numbers for the student to compute. The examiner reads a computation problem or a series of problems and problems which cannot be repeated. The student must answer the problem orally within 15 seconds.

Applications

9) **Measurement** -- 24 items include comparisons, non-standard units, standard units: length, area and standard units: weight, capacity.

10) **Time and Money** -- 24 items evaluate a student's ability to complete tasks , i.e., identifying passage of time, using clocks and clock units, monetary amounts to $1 and monetary amounts to $100.

11) **Estimation** -- 18 items in which the student solves problems by estimation. Items include whole and rational numbers, measurement and computation.

12) **Interpreting Data** -- 18 items are used to evaluate a student's ability to read and interpret charts and tables, graphs, probability, and statistics.

13) **Problem Solving** -- 18 items include solving routine problems, understanding non-routine problems, and solving non-routine problems.

The norm group consisted of 50 students for the two months period of ages 10-6-0 to 10-8-30 is 47, and the mean standard score is 100. (p.165)

The KeyMath-R fall testing U.S. norms for the fifth grade first month raw score is 48 for operations (p.310), which is exactly equivalent to the mean standard score of 100 (p.111). The Standard deviation is 15. The scaled score mean for each subtest is 10 and the standard deviation is 3. For the fifth grade in the fall testing, the average raw scores were 13 for addition, 11 for subtraction, 10 for multiplication, 7 for division, and 7 for mental computation. (p.110)

WRAT-3, (The Wide Range Achievement Test, 3rd edition), was constructed by Gary S. Wilkinson and published by Wide Range, Inc. in 1993. According to the manual, the WRAT-3 has a single level format for use with all individuals aged 5-75. Two alternative test forms (BLUE and TAN) provide the three subtests that have been the mainstays of all previous editions of the WRAT (p.9). Its purpose "is to measure the codes which are needed to learn the basic skills of reading, spelling, and arithmetic" (p.10).

The WRAT that has three subtests on the BLUE and TAN is as follows:

1. Reading: recognizing and naming letters and pronouncing words out of context.
2. Spelling: writing name, writing letters and words to dictation.
3. Arithmetic: counting, reading number symbols, solving oral problems, and performing written computations. (p.9)

The norm group consisted of 44 students for the sixth-month period of ages 10-0 to 10-6. Normative average raw scores in arithmetic range from 31 to 32, and standard scores from 98 to 102. (p.71) Standard scores "are the type of scores used for comparisons within individuals and between them ... Each age group has a scale mean of 100 and a standard deviation of 15" (p.33).

The Arithmetic subtest consists of 55 items with a time limit of fifteen minutes. Items are arranged sequentially by order of difficulty with an internal consistency correlation of .85 for item difficulty at age 10.

The manual of the WRAT-3 (p.33) provides the classification and score range for standard scores. The ratings of standard scores are as follows:

CLASSIFICATION	SCORE RANGE
Very Superior	130 and up
Superior	120 to 129
High Average	110 to 119
Average	90 to 109
Low Average	80 to 89
Borderline	70 to 79
Deficient	69 & below

Subjects

Two classes of Chinese children (n = 50; n =44) were randomly chosen from among the fifth grade classes in a Shanghai school district. Students were enrolled in grade 5.1 at the time of the test, that is, fifth grade one month. A personal interview through correspondence was held with a fifth grade mathematics teacher about the contents of the mathematics curriculum the Chinese fifth graders studied. The gender proportions of the students was 24 female students (55%) and 20 male students (45%) in the WRAT-3 test and 24 female students (48%) and 26 male students (52%) in the KeyMath-R test.

Testing Schedule

The subtests (four operations) of the KeyMath-R, a diagnostic inventory of essential mathematics and the second part (arithmetic) of WRAT-3, a wide range achievement test, were used. Chinese fifth graders completed each test in 15 minutes as required.

The Collection of the Data

The scores of the Chinese fifth grade mathematics classes were collected and computed according to the standard procedures of each test (See Tables 4.2 to 4.7 in Chapter 4). The mean scores of the Chinese students were compared to those of American norms recorded in the KeyMath-R and the WRAT-3 manuals. The analysis of the data collected was detailed in Chapter 4 (Also see Appendices 1 and 2).

In order to calculate a KeyMath cluster score for operations, the mental computation score was assigned as an average of the four operations.

Analysis of the Data

To test the null hypotheses of no difference between American Norms and Chinese students, the standard error for the mean (SEM) of the sample tested was computed in order to test the data using a t-test with the formula:

$$t = \frac{m - n}{SEM}$$ with m = the sample mean
n = the norm mean

$$SEM = \sqrt{\frac{ss}{n\,(n-1)}}$$ ss: $sx^2 - \frac{T^2}{n}$

A significance level of .05 is used to reject the null hypotheses.

In order to test the null hypothesis of no difference between male and female Chinese 5th graders, a regular test of means was conducted.

Chapter 4

Findings

Results of the Data

Appendix 1, the KeyMath-R test (n = 50), shows scores for 24 female students (48% of the total) and 26 male students (52% of the total).

Table 4.1 shows comparison of subject distributions by sex. The Chinese sample was roughly equally distributed between males and females as was the standardization sample for American fifth-graders.

TABLE 4.1 KeyMath-R

SUBJECTS

U.S. FALL NORM SAMPLE		CHINESE SAMPLE	
M	F	M	F
48	45	26	24

The U.S. sample (in Table 4.1) was very diverse in races, socioeconomic status, and geographic regions. Chinese students (in Table 4.1), on the other hand, were not diverse. They were not different socioecomically and regionally. They also belonged to one race, the *Han*. They were also the "only child" in the family. There was no information available regarding siblings or birth order in the U.S. norm sample.

Table 4.2 shows the score summary of the Operations. The mean standard score of the operations cluster was 123 with the standard deviation of 11.9, more than one and one half standard deviations higher than the American average (100). Among the four operations, subtest scaled scores varied from 2 to 7 points higher than the American average of 10.

Table 4.2

Chinese Fifth Grade KeyMath-R Score Summary (Fall norms) (n = 50) by grade norms (5.1)

OPERATIONS

Subtests	Raw scores	SD	Scaled Scores	SD	%ile Ranks
Addition	14.3	(1.1)	12		75
Subtraction	13.5	(1.4)	14		91
Multiplication	12.1	(1.1)	12		75
Division	12.0	(0.5)	17		99
Mental Computation	9 (assigned)		12		75
OPERATION AREA			Standard Score		%ile Rank
Raw Score	61.8	(2.6)	123	(11.9)	93
Grade Equivalent	6.3				
Age Equivalent	11-7				

Note: the mean scaled score is 10, and the standard deviation is 3.

In Table 4.2, the total raw scores of the Operations was 61.8, whose standard score was 123. This is more than one standard deviation higher than the norm. The grade equivalent of 6.3 was 1.2 grades higher than the U.S. norm (6.3 - 5.1). The Chinese age equivalent of 11-7 was one year and one month (1-1) higher than the U.S. norm (11-7 - 10-6).

To test for a hypothesis of no statistically significant difference between the Chinese and American means on the KeyMath-R, the 3.9 standard error of measurement for the

Operations Cluster was divided into the difference, resulting in t = 5.6, (df = 40), two tailed test, p =.001. The null hypothesis of no significant different was rejected. A highly significant statistical difference existed between the groups. Chinese students scored markedly higher in arithmetic calculation skills.

According to the manual of the KeyMath-R (p.310), the beginning fifth grade (5.1) norm raw score is 48 for operations, which is exactly equivalent to the standard score 100 (p.111). The mean raw score of the operations cluster was 61.8 with the extraordinarily small standard deviation of 2.6. The standard deviation of 2.6 showed that these students were extremely close to each other in skill level with very little variation.

Table 4.3

Chinese fifth Grade KeyMath-R Score Summary By Age Norms (Age 10-6)

Subtests	Raw scores	Scaled Scores	%ile Ranks
Addition	14.3	11 -12	75
Subtraction	13.5	12	91
Multiplication	12.1	11	75
Division	11.98	14	99
Mental Computation	9 (assigned)	12	75

The table 4.3 shows the raw scores and scaled scores of each subtest made by Chinese children by age at testing 10-6. All scores were reduced by one or more scaled score points when age comparisons were used. Deriving scaled scores from age norms appeared to provide the most conservative subtest comparisons.

According to the manual of the KeyMath-R (p.54), in the four operations, the norms of subtest raw scores for the fall testing are shown in Table 4.4:

Table 4.4

Chinese student raw score advantage compared KeyMath-R operations norms with Chinese Sample (n =50)

	Norm Raw Score	Chinese Raw Scores	Advantage
Addition	13.0	14.3	1.3
Subtraction	11.6	13.5	2
Multiplication	11.0	12.1	1.1
Division	7.2	11.98	5

In comparison with the scores of the Chinese fifth graders (*see* Appendix 1) with the above scaled score norms, the Chinese fifth graders were higher by the following scale score values in comparison to U.S. norms: addition 1.3 points; subtraction 2 points; multiplication 1.1; and division 5 points. If the Chinese fifth graders had completed the first semester (fall) of the fifth grade at the time of testing, they would probably have scored even higher, because the manual provided the norm with the entire fall of the fifth grade.

Chinese children probably made high scores in division because they were taught subtraction, multiplication and division almost an entire year earlier than American children.

Table 4.5

Chinese and U.S. KeyMath-R Distributions by Score Classification

(n = 50)

CLASSIFICATION	Chinese SCORE RANGE	STUDENTS	%	U.S. Norm Expected %
Markedly Above Average	125 +	20	40	5
Above Average	111 - 124	21	42	20
Average	90 - 110	9	18	50
Below Average&below	89 & below	0	0	25

Table 4.5 shows that in the KeyMath test, 20 students (40%) were markedly above average, a proportion which was substantially more than predicted in American Norm. Twenty-one students (42%) were above average. This, too, shows more than was predicted in the Norm. Nine students (18%) were average, which was a smaller proportion of normal students than predicted in American Norm. None of the Chinese fifth graders were below average. In other words, the Chinese distribution of fifth graders showed a marked shift to higher classification than the American distribution in Operations skills.

In the **WRAT-3** test (n = 44), the Chinese sample consisted of 24 female students (55% of the total) and 20 male students (45% of the total). Their average age was 10 years and 6 months old (10-6). The mean raw score was 36.1, and the standard deviation was only 1.5 (again, extremely consistent skills levels among the students). The mean standard score was 116.8 with standard deviation 7.1, indicating on average one standard deviation higher than the American norm of 98 - 102 (p.71). The mean grade score was 6.8 (standard deviation .81) which is 1.7 grades higher than American norms. (Also see Appendix 2)

The following are the ratings of standard scores of the WRAT-3 classification and score range for the Chinese fifth graders:

Table 4.6

Chinese and U.S. WRAT-3 Distributions by Score Classification

(n = 44)

CLASSIFICATION	SCORE RANGE	Chinese STUDENTS	%	U.S. Norms Expected %
Very Superior	130 and up	3	7	2
Superior	120 to 129	12	27	8
High Average	110 to 119	23	52	15
Average	90 to 109	6	14	50
Low Average &Below	89 & below	0	0	25

Table 4.6 shows that in WRAT-3 test, 3 students (7%) were very superior, 12 students (27%) were superior, 23 students (52%) were high average, and only 6 students (14%) were average, revealing a distribution which is markedly skewed to superior and high average by comparison with American norm.

The t-test for test of difference in means on the WRAT-3 showed $t = 2.83$, p .01 ($df = 40$) two-tailed test based on a standard error of measurement of 6. The hypothesis of no difference between Chinese and American means was rejected. Compared with the raw scores or standard scores of the WRAT-3 arithmetic subtest, the Chinese fifth graders (age 10-6 to 10-11), achieved more than one standard deviation higher than the U.S. norm group. On average, the Chinese fifth graders scored at the 6.8 grade level, almost two grades higher than U.S. counterparts at the beginning of fifth grade at the time of their testing the WRAT-R.

From the analysis of the results of the test, the Chinese fifth graders, compared with the norms of the WRAT-3 test scores, were consistently and markedly better in mathematics than American fifth graders.

The following Table 4.7 shows the skill difference at the ceiling levels of the KeyMath-R and the WRAT-3.

Table 4.7

Skill Differences At Ceiling Levels

KeyMath-R

U.S Norms (n = about 95) diverse, homogeneous			Chinese Sample (n =50) heterogeneous	
Raw Score		Skill	Raw Scores	Skill
+	13	adding of decimals 3 places using decimal. No fractions	14.3	adding fractions using decimals
-	11	3 column subtraction, no regrouping, no decimals	13.5	subtracting, fractions, using decimals
x	10	3 column x 1 column no regrouping, no decimals	12.1	2 column whole No. multiplication, using zero in multiplication, using decimals
÷	7	2 column ÷ single column no remainder	12	3 digit number ÷ 2 digit number no decimals

WRAT-3

U.S Norms (n = about 95) diverse, heterogeneous		Chinese Sample (n =44) homogeneous	
Raw Scores	Skill	Raw Scores	Skill
31 - 32 (Av. 31.5)	subtraction using decimal and division 3 digit ÷ single divisor no remainder	36	square division 3 digit ÷ 1 digit divisor with remainder

Male students were sometimes assumed to be superior to female students in math. Curiously enough, it was found that scores between male and female Chinese fifth graders who were tested with the KeyMath-R and WRAT-3 were essentially the same as shown in the following table (4.8):

Table 4.8

Comparison of Arithmetic Skills of Male and Female Chinese Students by Gender

		Average Raw Score	Standard Scores
KeyMath-R	M=26	61.96	126
	F=24	61.58	25
WRAT-3	M=20	36.3	115
	F= 24	36	115

From a Chinese interpretation, female students in primary schools achieved higher scores than male students. In middle schools, male students achieved a little higher scores than female students, but in high schools, most of the male students achieved higher scores than female students in mathematics, physics, and chemistry, because men choose to pursue studies in math and science and females choose other fields. Female students were often better in language subjects than male students.

The Chinese students apparently were confused with certain format of American math expression on the tests. For example, Chinese students did not know the positive and negative signs written that way in the tests, i.e., $^{+}17 - {}^{-}13$ or $^{+}17 + {}^{-}15$, because in China, both signs were written within parenthesis and at the left middle of the number, i.e., (+17) - (-13) or (+17) + (-15). Additionally, zero was kept before the decimal point, such as 0.81, 0.072, etc., but in America, children were taught not to keep the zero, writing the decimals as .81, .072, etc. Furthermore, in America, the fraction (in addition and subtraction) was usually arranged vertically, but they were arranged horizontally in China (whether the denominators were the same or not), i.e., $\frac{1}{7}+\frac{3}{8}$, $\frac{6}{17}-\frac{5}{17}$, etc. With the tests used on Chinese children, the writer noticed that the different math format appeared to reduce the Chinese test scores for both tests. If the U.S. format were consistent with the Chinese customary format, the Chinese sample may have scored higher than the scores shown.

Chapter 5

Conclusions

The purpose of this study was to compare a sample of Chinese beginning 5th graders to American norms on tests of arithmetic calculation skill. This study confirmed that fifth-grade Chinese children performed markedly better in arithmetic achievement than the American averages. These Chinese children revealed marked superiority in math achievement as compared to the American children in the norm groups for the KeyMath-R and the WRAT-3. Their standard scores were higher than the American norms, achieving one to two standard deviations higher, the equivalent of one to two years higher than the U.S. sample at the beginning of fifth grade. Thus the Chinese norm appeared to be much higher than the U.S. norm.

If certain U.S. notational conventions had been explained in advance to the Chinese students, and more time allowed on the KeyMath-R and WRAT-3, their scores would surely have been higher yet. For example, Chinese students were not familiar with the positive and negative signs written that way, i.e., $^{+}17 - {}^{-}13$ or $^{+}17 + {}^{-}15$. They were also unfamiliar with the decimals written as .81, .072, etc., instead of 0.81 and 0.072. Besides, in America, the fraction (in addition and subtraction) was usually arranged vertically, but arranged horizontally in China (whether the denominators are the same or not), i.e., $\frac{1}{7} + \frac{3}{8}$, $\frac{6}{17} - \frac{5}{17}$, etc. Inspection of the Chinese children's tests revealed that the different math format appeared to affect the scores for both tests. In future sampling of Chinese students, these differences should be explained before testing begins. Besides, if the KeyMath is used in the future, the calculation section should be untimed.

In explaining possible causes for the differences found in this study, the review of the literature revealed marked cultural differences between the groups. Even if they were assigned four times as much homework as American children, the Chinese children did not feel bored with it. They thought of doing homework as strengthening what they were presented in classroom. Chinese children, when young, were filled with Confucian doctrine from which many Chinese sayings were derived such as "One cannot succeed without great effort"; "Innate geniuses also need hard work", etc. Additionally, Chinese parents, who held a long tradition of reverence for school achievement, considered that knowledge was acquired through effort. Influenced by their parents education and culture, Chinese children placed more emphasis on school achievement, so they studied hard, harder than American children.

Although Chinese teachers received less education than American teachers who had at least bachelor's degree, they showed more positive attitudes towards mathematics teaching and they tried to make students understand basic concepts and help them develop the ability to solve problems in mathematics. Chinese schools and teachers were more responsible to their students in academic achievement and Chinese students had longer schools days (about 280 days) in a year than American students (about 180-200 days). Moreover, Chinese teachers and parents had good cooperation with one another in promoting students' learning and teachers' instruction. The most salient reason for Chinese children to have better performance in mathematics was the "only child policy" which pushed them forward. These factors may easily explain why Chinese children showed better achievement in mathematics than American children.

Because of early compacted math curriculum in China, a marked math advantage took place during the first four years of school. Both the addition and subtraction were taught in first grade, putting the Chinese children a year ahead of U.S. counterparts when entering second grade. By the end of the fourth grade, Chinese students were still a year ahead; they stayed and they surged ahead -- 1.5 years ahead by early fifth grade. In math study, Chinese students should master the basic four operations by the end of the fourth grade. If students could not master or reach the required level, they may repeat the same grade until the teacher was satisfied. Thus teachers take advantage of the situation by pushing on into advanced curriculum.

American children, on the other hand, had deficiencies in mathematics that appeared as early as kindergarten and persisted throughout elementary school. "In some districts," as Palmer (1989) pointed out with regard to Chicago students, "the kindergarten class was a special concern since students typically ended the kindergarten year almost a year behind national norms" (p.71). Additionally, American children spent less time on study and showed less positive attitude toward study as well.

According to Stanley (1994), 89% of American people think that American students have the capability to learn mathematics, indicating that "The entire U.S. public believes that most students are capable of learning more math and more science than they generally do" (p.51). According to the 1995 National Education Goals Report, the proportion of American 4th graders meeting the new mathematics performance standard comprised 13 % in 1990 and 18% in 1992, indicating that American students made significant progress over the two-year period. Although the progress was slow, American students' mathematics performance improved steadily. American students have many advantages over Chinese students: the capability to learn mathematics, certified teachers, their teachers with higher level of education, and advanced computer technology and other facilities. Also, American mathematics textbooks are far better designed than the Chinese textbooks.

President Clinton presented his wider vision of preparing America for the 21st Century in his second Inaugural address in which he asked for a higher standard for American students in order to meet standards for a world-class education. From a Chinese interpretation of this situation, many things should be considered to improve U.S. math achievement: first, teachers should be more responsible for the student's learning. Teachers should patiently spend more time on students academic achievement, treating students as their own children, before referring them to special education. Second, individual teaching quality should be frequently evaluated. It is suspected that few teachers know how to teach and what to teach in mathematics just by obtaining a teaching certificate or licensure. Examination for quality teaching of mathematics should be the order of the day in considering teachers for promotion. Third, mathematics curriculum should be re-constructed for good quality teaching processes. Fourth, textbooks must be unified throughout each district and should be changed every three years in order for teachers to advance themselves through the idea that "Teaching is also learning" (new textbooks help teachers learn something new through teaching). Fifth, a teacher will teach one subject instead of all subjects for many grades. For instance, a math teacher can teach math (and only math) to students in all of the primary grades. Sixth, if students are not successful at a particular level, especially before the fourth grade, they must repeat the course until they succeed. They must master the four Operations by the end of the fourth grade. Seventh, American children must be educated to strive hard in mathematics. Eighth, parents should invest more time or money in children's education, including after school tutoring by volunteers or professionals, and parents coaching and helping math homework completion.

In future studies, examination of Chinese kindergarten and first grade math curriculum and instruction is indicated.

Appendix 1 (KeyMath-R)

ST.#	Sex	Age	MC	+	–	X	÷	TRS	GE	AE	SS	%ile
1	M	11-1	9	16	15	12	12	65	6.9	12-2	120	97
2	F	10-7	9	15	15	12	12	64	6.8	12-0	130	99
3	M	10-1	9	15	15	13	12	65	6.9	12-2	145	99
4	F	10-9	9	15	14	13	12	64	6.8	12-0	124	99
5	F	9-11	9	14	13	12	12	61	6.4	11-8	145	99
6	F	10-6	9	14	13	12	12	61	6.4	11-8	124	99
7	F	10-9	9	13	13	12	13	61	6.4	11-8	117	96
8	M	11-8	9	14	11	12	12	59	6.2	11-6	102	66
9	F	10-5	9	14	13	13	11	61	6.4	11-8	131	99
10	M	10-11	9	15	11	12	12	60	6.3	11-7	115	95
11	F	10-2	9	14	14	13	11	62	6.5	11-10	142	99
12	F	10-7	9	13	15	13	11	62	6.5	11-10	126	99
13	M	10-3	9	14	11	12	12	59	6.2	11-60	126	99
14	F	10-2	9	16	16	13	12	67	7.2	12-50	145	99
15	F	10-9	9	13	13	10	11	57	6.0	11-4	110	87
16	F	11-0	9	13	13	13	12	61	6.4	11-8	112	91
17	M	10-5	9	14	14	13	11	62	6.5	11-1	133	99
18	M	10-5	9	17	16	13	13	67	7.2	12-5	145	99
19	M	10-2	9	16	13	12	12	63	6.7	11-11	144	99
20	M	11-3	9	14	14	13	12	63	6.7	11-11	110	88
21	F	10-3	9	16	15	13	12	66	7.1	12-4	143	99
22	F	10-0	9	13	13	12	12	60	6.3	11-7	137	99
23	M	10-0	9	16	15	12	12	65	6.9	12-2	145	99
24	F	10-10	9	13	14	14	12	63	6.7	11-11	122	98
25	M	10-10	9	13	13	10	12	58	6.1	11-5	112	90
26	F	10-6	9	14	13	10	12	59	6.2	11-6	119	97
27	M	10-9	9	14	14	13	12	63	6.7	11-11	122	98
28	M	10-9	9	15	13	10	12	60	6.3	11-7	115	95
29	M	10-5	9	15	15	12	12	64	6.8	12-0	138	99
30	F	10-1	9	14	13	10	12	59	6.2	11-6	134	99
31	F	10-6	9	13	13	12	12	60	6.3	11-7	121	98
32	M	10-8	9	13	15	12	13	63	6.7	11-11	128	99
33	F	10-8	9	15	14	10	12	61	6.4	11-8	124	99
34	M	10-10	9	14	15	13	12	64	6.8	12-0	124	99
35	M	10-9	9	14	13	14	13	64	6.8	12-0	124	99
36	F	10-1	9	16	14	14	12	66	7.1	12-4	145	99
37	M	11-1	9	15	16	12	13	66	7.1	12-4	122	98
38	F	10-2	9	14	13	10	12	59	6.2	11-6	134	99
39	F	10-6	9	15	13	12	12	62	6.2	11-10	126	99
40	F	10-11	9	15	12	12	12	61	6.4	11-8	117	96

To be continued on the next page

Appendix 1 (KeyMath-R)

ST.#	Sex	Age	MC	+	-	X	÷	TRS	GE	AE	SS	%ile
41	M	11-0	9	15	10	13	12	60	6.3	11-7	110	88
42	F	10-9	9	13	13	12	12	60	6.3	11-7	115	95
43	F	12-5	9	14	12	13	12	61	6.4	11-8	97	53
44	M	11-0	9	11	12	10	11	54	5.7	11-1	102	68
45	M	11-0	9	13	12	12	12	59	6.2	11-6	108	84
46	M	11-0	9	14	12	11	12	59	6.2	11-6	108	84
47	M	11-0	9	15	14	13	12	64	6.8	12-0	118	96
48	M	11-0	9	14	15	12	12	63	6.7	11-11	115	95
49	M	11-0	9	15	13	12	12	62	6.2	11-10	113	93
50	M	11-0	9	14	12	12	12	60	6.3	11-7	110	88
TL.		533-7	450	714	673	605	599	3089	317.	590-3	6190	
AV.		10-6	9	14.28	13.46	12.1	11.98	61.8	6.3	11-7	123	
SD				1.1	1.4	1.1	.5	2.6			11.85	
Effect sizes				1.43	1.15	.7		.66			2.06	

Note: ST.# = students' number; MC = mental computation; TRS = total raw scores; GE = grade equivalent; AE = age equivalent; SS = standard scores; %ile = percentile; SD = standard deviation.

Appendix 2 (WRAT-3)

ST.#	SEX	AGE	R S	S S	A S	GS	%ile
1	F	11-0	36	111	512	7	77
2	M	10-1	39	126	517	8	96
3	M	10-7	36	121	512	7	92
4	F	10-9	36	115	512	7	84
5	F	9-11	38	134	516	8	99
6	F	10-6	36	115	512	7	84
7	M	10-9	36	115	512	7	84
8	M	11-8	34	101	507	6	53
9	F	10-6	35	117	510	6	87
10	M	10-11	34	109	507	6	73
11	F	10-2	37	124	513.7	7	95
12	F	10-7	36	115	512	7	84
13	M	10-3	37	124	513.7	7	95
14	F	10-2	39	131	517	8	98
15	F	10-9	36	115	512	7	84
16	F	11-0	36	111	512	7	77
17	M	10-5	37	124	513.7	7	95
18	M	10-5	39	131	517	8	98
19	M	10-2	36	121	512	7	92
20	M	11-3	37	114	513.7	7	83
21	F	10-3	36	121	512	7	92
22	F	10-0	35	117	510	6	87
23	M	10-0	38	122	516	8	93
24	F	10-10	38	122	516	8	93
25	M	10-10	36	115	512	7	84
26	F	10-6	35	112	510	6	79
27	M	10-9	37	119	513.7	7	90
28	F	10-9	38	122	516	8	93
29	M	10-5	35	117	510	6	87
30	F	10-1	34	114	507	6	83
31	F	10-6	37	119	513.7	7	90
32	F	10-8	37	119	513.7	7	90
33	M	10-8	38	122	516	8	93
34	M	10-10	35	112	510	6	93
35	M	10-9	35	112	510	6	93
36	F	10-1	37	124	513.7	7	95
37	M	11-0	36	111	512	7	77
38	F	10-2	34	114	507	6	83
39	M	10-6	35	112	510	6	93
40	F	10-11	33	105	505	5	63
41	M	11-0	36	111	512	7	77
42	F	10-9	34	109	507	6	73
43	F	12-5	38	109	516	8	73
44	F	10-6	33	105	505	5	63
Total		467-1	1590	5139	22527.6	301	
Average		10-6	36.1	116.8	512	6.8	
SD			1.5	7.1	3.2	.81	
Effect sizes				1.12			

Note: ST.# = students' number; RS = raw scores; SS = standard scores;
AS = absolute scores; GS = grade scores; %ile = percentile; SD = standard deviation.

Appendix 3

The Fifth-grade Mathematics Curriculum
Issued by Teaching and Research Department, Shanghai Education Bureau, Shanghai, P.R.C (October 1994)

The first semester

Students should master:

1. decimal multiplication, decimal division, recurring decimals, approximate value of product and quotient, decimal multiplication done by the abacus;

2. mixed computation of four operations of decimals and their story problems, general or more complicated story problems done through comprehensive formula and three-step formula, a little complicated average done from story problems.

3. triangle, parallelogram and trapezoid triangle, the sum of interior angles of a triangle, isosceles, right triangle, symmetry, trapezoid;

4. measure of land: the Chinese units of land (*mu*, *fen*, are(a.)), linear measure and measure to find its area (including the way of range estimation and pacing), draw rectangles and squares on the ground, compute areas according to the results of measure.

5. review.

Teaching contents in the current math textbook:

1. multiplication and division of decimals:
   a) decimal multiplication;
   b) decimal division;
   c) review.

Note: recurring decimals are only taught, but not examined.

2. mixed computation of the four operations and their story problems:
   a) mixed computation of the four operations;
   b) story problems of the mixed computation of the four operation;
   c) review

Note: only four steps used in the mixed computation of four operations.

3. triangle, parallelogram and trapezoid:
   a) the knowledge of parallelograms; and
   the computation of the areas of parallelograms;
   b) the knowledge of triangle; and

the computation of the areas of triangles;

c) the knowledge of trapezoids; and
the computation of the areas of trapezoids;
d) review.

Note: 1) students are required to make the heights only within triangles, parallelograms and trapezoids, and be able to observe the heights outside triangles, parallelograms and trapezoids. 2) students are not tested for the computation of the sum of interior triangles, and for the computation of the degree of one unknown angle in a triangle.

4. measure of land:
   a) measure land;
   b) compute the areas of land;
   c) review.

Notes: students are required to compute areas, using metric systems.

5. simple equation
   a) express numbers with alphabet.
   b) simple formula (e.g. $ax \pm b = c$, $ax \pm bx = c$)
   c) make formula and solve the formula derived from story problems.

6. general review.

The above is the English translation translated by the writer, Wen Yuan Gu, from the original Chinese current mathematics curriculum for the first semester of the fifth Chinese graders in Shanghai, P. R. C. The curriculum began to be used in October 1994 after the second revision (the first revision took place in 1992).

Appendix 4

Mathematics Curriculum (1-5)
Issued by Teaching and Research Department,
Shanghai Education Bureau, Shanghai, P.R.C
(October 1994)

CHINESE STUDENTS MATHEMATICS

GRADE	CONTENTS	EXAMPLES
1	addition, subtraction within 100	78 + 11 =? 29+37 = ? 88 - 17 = ? 50 - 13 = ? ...
2	multiplication/division within 100	7 x 8 = ? 6 x 9 = ? 81÷ 9 = ? 49 ÷ 7 = ? ...
3	addition/subtraction of multiple-digits (3 to 5 digits)	328 + 125 = ? 1987 + 987=? 52352 - 1238 = ? ...
	multiplication with 2-3 multipliers	1325 x 79 = ? 1450 x 252 = ? ...
	division with 1-2 divisors	100 ÷ 5 = ? 125 ÷ 25 = ? 7240 ÷ 8 = ? ....
	oral computation with division with 1- 2 digits dividend	72 ÷ 3 = ?
	multiplication with 1 multiplier	45 x 3 = ? 17 x 7 = ? ...
	know the meaning of ( ) and learn how to do mixed computation with 2 - 3 steps.	128 + (25 ÷ 5) = ? 200 + (35 x 15) -128 = ? ....
	know the simple decimals and learn how to do addition/subtraction of simple decimals	1.5 + 0.5 = ? 71.3 + 1.7 =? 80.5 - 10.5 = ? 10.7 - 1.9 = ? ...

	Know the count units	*wan* = 10,000 *yi* = 100,000,000
3	addition/subtraction, multiplication with 1 - 2 digits multipliers done by the abacus	
	solve story problems with application	56 x X = 116480 32 x X = 258880 ...
4	multiplication/division of 4-5 digits with 2-3 digit multipliers/dividends	213 x 25 = ? 1231 x 917 = ? 785 x 201 = ? 28413 ÷ 123 = ? ....
	oral computation of 2 digit dividend by 2 digit divisors	72 ÷ 24 = ? 90 ÷ 30 = ? 96 ÷ 16 = ? ...
	mixed four operations computation	(180 - 4) ÷ 22 + 3 x 8 = ? 271+ [238 + 120 x (42 - 14) ÷ 4- 6] ÷ 5 =? .....
	basic knowledge of fraction	$\frac{1}{2}$, $\frac{3}{4}$, $\frac{2}{5}$ ....
	the addition/subtraction of fraction with the same denominators	$\frac{1}{6}+\frac{3}{6} = ?$ $\frac{16}{17}-\frac{13}{17} = ?$ ...
	the addition/subtraction of decimals	7.19 + 8.81 = ? 198.45 - 77.76 = ? ...
	addition/subtraction of positive and negative	(+15) + (+7) = ? (+6) + (-5) = ? (-7) + (+5) = ? (-8) - (-2) = ? .....
5	addition/subtraction of decimals with complicated numbers	179.001 - 2.227 = ? 179.0001 + 179.9999 = ? ...
	multiplication/division of decimals	82.5 x 0.001 = ? 77.31 x 2.81 = ? ...

5	mixed computation of four operations with decimals	$17.25 + (3.7 \div 0.2) \times 2.1 = ?$ $27.19 + [28 - (17 \div 2) \times 3.8] \times 3.7 = ?$ .....
	relationship of fraction and decimal	$\frac{1}{2} = 0.5$ $\frac{3}{6} = \frac{1}{2} = 0.5$ ...
	addition/subtraction of fraction	$\frac{1}{12} + \frac{1}{3} = ?$ $\frac{17}{18} - \frac{5}{6} = ?$ $1\frac{1}{4} + 2\frac{3}{4} = ?$ ...
	multiplication /division of positive and negative numbers	$(-3) \times (+5) = ?$ $(-65) \times (-16) = ?$ $(+18) \div (-3) = ?$ $(-18) \div (-3) = ?$ ...
	absolute value	$\lvert -4 \rvert = ?$ $\lvert +7 \rvert = ?$ ...
	others	$ax \pm b = c$ $ax \pm bx = c$

Note: The above is the contents (translated by the writer, Wen Yuan Gu) of the original Chinese current math curriculum for grades 1 - 5. This is the excerpt mainly on computation from the whole Chinese math curriculum. The curriculum began to be used in October 1994 after the second revision (the first revision took place in 1992). Throughout China's schools, all the textbooks are unified/same.

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