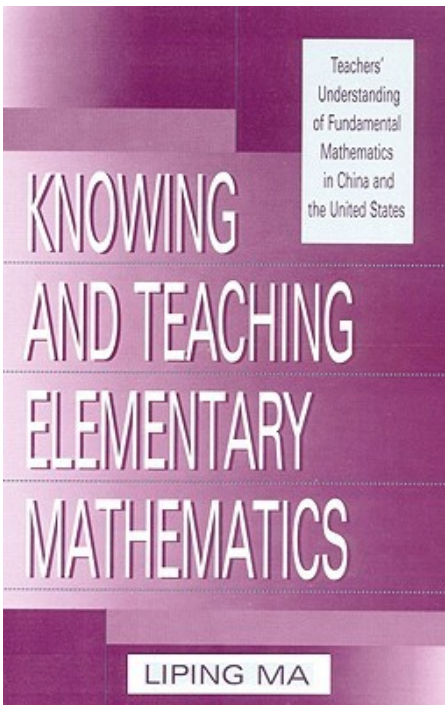

Knowing and Teaching Elementary Mathematics: Teachers' Understandng Fundamental Mathematics in China and the United States

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Chinese students typically outperform U.S. students on international comparisons of mathematics competency. Paradoxically, Chinese teachers receive far less education than U.S. teachers--11 to 12 years of schooling versus 16 to 18 years of schooling.

Studies of U.S. teacher knowledge often document insufficient subject matter knowledge in mathematics. But, they give few examples of the knowledge teachers need to support teaching, particularly the kind of teaching demanded by recent reforms in mathematics education.

This book describes the nature and development of the "profound understanding of fundamental mathematics" that elementary teachers need to become accomplished mathematics teachers, and suggests why such teaching knowledge is much more common in China than the United States, despite the fact that Chinese teachers have less formal education than their U.S. counterparts.

The studies described in this book suggest that Chinese teachers begin their teaching careers with a better understanding of elementary mathematics than that of most U.S. elementary teachers. Their understanding of the mathematics they teach and--equally important--of the ways that elementary mathematics can be presented to students, continues to grow throughout their professional lives.

Teaching conditions in the United States, unlike those in China, militate against the development of elementary teachers' mathematical knowledge and its organization for teaching. The concluding chapter of the book suggests changes in teacher preparation, teacher support, and mathematics education research that might allow teachers in the United States to attain profound understanding of fundamental mathematics.

Knowing and Teaching Elementary Mathematics: Teachers' Understandng Fundamental Mathematics in China and the United States Details

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From Reader Review Knowing and Teaching Elementary Mathematics: Teachers' Understandng Fundamental Mathematics in China and the United States for online ebook

Ben says

This is a really interesting investigation into the differences between Chinese and American math teaching and teacher preparation. For me, this book opened up and excited me about the nuances of teaching arithmetic. There are a huge amount of analogies, comparisons, and various mental models in play when we teach even simple math, and they are strongly affected by language. The teacher's deep level of understanding of the math is critical to sorting through the possible misconceptions and guiding students to their own deep understanding. The translated discussions with the Chinese teachers are amazing in this area. So, the book is kinda dorky, but pretty interesting if you are into math, cultural differences, or thinking about the role of analogies in learning.

Emily says

I realized reading this book that my understanding of arithmetic is very incomplete. I was taught arithmetic in a very procedurally focused way, without a lot of insight into the "why" behind arithmetic operations. The descriptions of the depth of understanding of the Chinese teachers into various ways of presenting and teaching basic concepts of arithmetic was astounding to me. I was never taught this way and although I went on to get a bachelor's and master's degree in statistics, never realized how much I could learn about arithmetic. I am very glad to have read this book. It has opened my eyes to the level of preparation and understanding needed to effectively teach elementary mathematics. I wish our schools had elementary math specialists like the Chinese system has.

Kim B. says

Not very helpful. I think people are scared to engage in conversation with children about math and relax, so they make up rules from observations to say one method of teaching subtraction, Multiplying and whatever else I missed in the book before I quit reading it to keep my sanity,is better than another way, leaving out the fact that teachers were put on the spot. I absolutely hate trying figure out why breaking up numbers into parts to make it easier is better than just adding or subtracting the original numbers. I'm glad I only borrowed it from the library.
Reminds me of common core nightmare stories!

Barb says

It was both enlightening and discouraging to read this book which compares the teaching of mathematics in the US and China. It was written almost 10 years ago and I'd like to think US teachers have improved their teaching of math in that time. Still, many of the quotes from teachers in the discussion groups sounded real and could have come from me. It was interesting to see the different ways of thinking about how teachers do what they do.

Jacob says

This book is someone's dissertation, and although it's been "dressed up" it still reads like one. However, if you're able to read that kind of dryer content, and especially if you have young children, this book can be valuable on a couple of levels. First of all, it's a good argument for certain changes in our education system. Through interviews with American and Chinese math teachers on four specific math topics, the author demonstrates that a large reason for the disparity in student scores stems from the teachers in the US not having a good conceptual understanding of the material. Apparently, you can't teach something well if you don't understand it yourself! Who knew?

The author is clearly able to explain how the American teachers tend to focus their teaching efforts on the procedures and algorithms to perform mathematical computations, but these are rigid and prone to error because the teachers don't know why the procedures are necessary. The Chinese teachers, in contrast, demonstrate a deep conceptual understanding of the math behind the procedures, and tend to teach to that. This understanding appears to be developed during their teaching careers, as the Chinese teachers tend to behave more like mathematicians than teachers in terms of continuing to study math and work on math problems. They also interact with each other more to help each other learn the concepts and how to teach them, and they receive time to do these things during the work day.

The second way this book is helpful is that it explains the conceptual understanding of the four specific math topics: subtraction with borrowing, multidigit multiplication, division by fractions, and the relationship between the area and perimeter of a shape. Since I have young children that are learning these topics, I feel I can teach these four topics much better to my children now that I know what the important concepts behind them are. For me, the book was worth reading just for that.

This book didn't get five stars for two reasons: the dry writing (not a fault, just not a source of excellence for five stars either), and the author's push beyond a "conceptual understanding" to what she calls a "Profound Understanding of Fundamental Mathematics". The author tries to claim in her conclusion that this is a third level of understanding beyond procedural and conceptual, but I didn't see any solid evidence that her profound understanding was any different from a good conceptual understanding.

Aurora says

This book is a comparison of how teachers from the US and China understand various basic concepts in elementary mathematics. What is shocking is that the US teacher do not understand how to effectively teach these concepts, even though they have had more training than the average elementary school teacher in China. One reason for this discrepancy is the focus on the US on procedural knowledge. We want to rely so much on simple formulas and algorithms, handed to us to memorize and then "plug and chug," without really ever knowing what they are about. This doesn't help anyone learn math, it only helps us to memorize information that will be forgotten too soon down the road. What's worse is that as the math presented to the teachers in the book gets harder, the US teacher's procedural knowledge is also lacking. So not only are the US teachers unaware of how to effectively teach the concepts behind the formulas, but sometimes they don't even know how to teach the formulas themselves.
This book is a wonderful resource to use in order to learn about some more effective ways to teach math, conceptually, as well as a resource that points to many things that are not running as well as they should in math education in the US today.

Ilib4kids says

372.70973 MA(166p)
dividend ÷ divisor = quotient
Multiplier(factor, number of group) * multiplicand(factor: number in a group) = Product,
google search : devlin on multiplication(Keith Devlin): **multiplication is not repeated addition.**, no mention in this book.
Worth reading for parents try to help their children and teachers try to teach elementary arithmetic(addition, subtraction, multiplication, division). A great insight of elementary math teaching, procedural perspective teaching vs. Conceptual perspective teaching. Some arguments are very strong and persuasive, but I doubt the children can fully standard them.
My reading note:
1)Chapter1 subtraction with regrouping
A:decomposing a higher value unit p7
B:the rate of composing a higher value unit:10, which is 10 lower place value = 1 higher place value and the place value system addressing in chapter 2 are theories underneath addition, subtraction standard carrying or borrowing procedural algorithm, you always deal with number under 20. e.g 1536 - 722, after borrow one from 5, 5 become 4, 3 become 13, which actually 13 hundreds - 7 hundrends. see more on book p 42 - p43(multiplication), which make algorithm always work.
C.my thought of place value: the core of multiplication is another thinking place value idea.In multiplication decimal system unit value change from one unit, to tens unit, ... to justification move algorithm, you can also think as unit is multiplicand
D: Borrowing traditional term will illustrate standard subtraction procedure. lower place is "BORROW" from higher place.
I don't totally agree with author that decomposing should substitute borrowing term. Decomposing emphasis the "no value change" idea, borrowing illustrate subtraction procedure, they are 2 faces of the same thing.

2) Chapter 2: multidigit number multiplication.
p32-35 Ample evidence of teachers own incompetence regarding math subject knowledge. It remind me Finnish teachers high quality with master degree in subject discipline teaching. A huge concern

Observation:
Why my child start doing math from higher value place (left) instead of lower value place?
It puzzles me until I saw explanation on p20. We do it all the time even we are not fully aware of it. Example, how change I can get after paying $2 for something cost 1 dollars 63 cents. We first subtract 1 dollar, then rest 63 cents. That my daughter does whenever doing addition and subtraction, she has a strong concept with carrying and borrowing concept, keeping change value when she found carrying or borrowing happen, she figure out her idea's math operation rule when playing monopoly game. There is a great advantage doing this way, we can quick figure out how big the number is, get a rough idea. But doing in school standard way, when one column value is done it will fixed, it is logarithm, applied to any occasion, a great for computer: fixed prove procedure. but not always a best choice for some problem. That is why computers are best at boring unchanged satiation, such like calculating our bank balance, worse at artificial intelligence, such as pattern recognition, I like computer can be our friend help things our human not good at, instead of enemy.

Summary:
1. High concern about cramming arithmetic teaching (calculation teaching) in elementary school even it could be done correctly. Neuroscience study shows our brain (cortex) dealing with abstract number

operations not fully mature until adolescence. Teachers have to use manipulative to address simple math operation, such as 12 - 3. What is so different from take 3 apples from 12 apples to 12 - 3?
Dealing with apples so easy for children instead of purely math? The great invention of mathematics is a huge achievement ever human being made. The map from real world problems to abstract math world is a great leap that distinguish us from other animals. These abstract thinking are last physically developed in our brain. Too early to teach such knowledge not fitted to children brain level can bring a huge damage: lack creativity, less confidence.
2. Stop teaching arithmetic instead of focus on math concept teaching, like ratio, percentage, geometry, graph, even chaos, fractal or basically math history are well within children brain level.
“If you can't explain it to a six year old, you don't understand it yourself.”
? Albert Einstein

Commutative law of addition: $m + n = n + m$
Commutative law of multiplication: $m \cdot n = n \cdot m$
Associative law of addition: $(m + n) + k = m + (n + k) = m + n + k$
Associative law of multiplication: $(m \cdot n) \cdot k = m \cdot (n \cdot k) = m \cdot n \cdot k$
Distributive law of multiplication over addition: $(m + n) \cdot k = m \cdot k + n \cdot k$

Math teaching
1. Why Roman numerical system(I, II, IX,) inferior to Arabic numerical system (1,2 3,4): not straight, involving addition when figure number out, e.g. IX (4) = X(5) - I(1)
2. (a1/b1)/(a2/b2) = (a1/a2) /(b1/b2)
3. rate of higher place value of 10 underline carry, borrowing procedure
3. Chinese number system advantage, forty means five tens in chinese, ?? ???

Joe says

This reads very much like the dissertation it was originally, but that doesn't take away from it's great content. There is a clear distinction between the process based American math teacher perspective and the conceptual based Chinese math teacher perspective. The process dependent approach sadly leaves many students (and teachers) unable to explain, expand, understand the concepts behind the process. The conceptual based approach leads students and teachers to develop a wide variety of processes to exemplify and enliven the concepts. So much to consider here.

Sue says

I know of many teachers who could have explained this math with more conceptual understanding than the teachers who were presented for the United States in this book. This book has made me look differently at my teacher's editions, and I have noticed how limited the instruction is and the strong focus on procedure. I am more aware of how I present math lessons now. I was especially interested in the end chapter comparing U.S. teachers prep time with that of their Chinese counterparts. I'm a little jealous.

M says

This book was fantastic. Every elementary math teacher should read it. In China, elementary math teachers

only teach math. They have discussions and shared planning time. They actually spend a lot of time studying math. They don't assume they know it and are done. Because American elementary teachers teach all subjects, we don't have time to do what they do, which is a shame. We are so worried about math scores and international competition, but we don't make the changes that would truly make a difference. I have never talked to someone who understood math the way the Chinese teachers do. This book was inspiring because it shows how math can be taught. Unfortunately, we can't do all of what they do.

Alicia says

Liping Ma's research (the book is based on her dissertation at Standford University), shows how math teachers in the US consistently demonstrate a fragmented, shallow understanding of math concepts in comparison to their Chinese counterparts. This knowledge gap is likely a significant contribution to the perpetual lag in US public school math performance. Very compelling and highly recommended for teachers, homeschoolers, teacher educators and parents fed up with public school mathematics education.

Brian says

Deeply insightful. Helped me realize that although I have some strengths as a math teacher, I have so, so much to learn! So many of Ma's insights, or really, the insights of the teachers she interviewed, are directly applicable to my work with struggling mathematicians. Favorite quote - "The reason that one problem can be solved in multiple ways is that mathematics does not consist of isolated rules, but connected ideas. Being able to and tending to solve a problem in more than one way therefore reveals the ability and the predilection to make connections between and among mathematical areas and topics."

Hilary says

Or: "What you (I'm looking at you, college-educated American) think you know about elementary math but are really totally clueless about."

Ma demonstrates the difference in teachers' knowledge between China and the US in elementary mathematics. She explains the reasons behind differences in student comprehension and performance both on standardized tests and in life-long mathematical achievement. These reasons boil down to a primarily procedural understanding and explanation of elementary maths procedures, many of which are flawed in addition to their fundamental inadequacy. A deeper reason for the methods is the lack of knowledge inculcated in US teachers with regard to what Ma calls the "Profound Understanding of Fundamental Mathematics." In short, we simply do not give elementary math the credence it deserves. It is as essential as learning and understanding the alphabet and phonics.

I was sobered by my own lack of "PUFM." I was instructed in elementary math in the extremely shallow and sometimes flawed way Ma describes as typical of US classrooms. My own understanding being so limited, I hope to gain deeper knowledge as I seek it and as I strive to teach my own children deeply. I have been motivated to put into practice Chinese teaching techniques, such as class interaction/discovery/discussion, teaching the elemental aspect of a topic thoroughly and slowly the first time (and conceptually!), later to be reinforced as supportive topics are introduced and through the practice involved in perfecting the procedural aspect of the concept.

I also want to plan curriculum as suggested by Chinese instructors, including the incorporation of a standards-manual (I will use the California Math Standards) to guide my use of my chosen math curriculum. I will also seek to make more time to read, understand, and develop math lessons before teaching them.

Key to Chinese instructors is an understanding of the interconnectedness of math concepts as well as the calling-upon of mathematical laws even among the youngest students. Asian teachers also tend to describe their conclusions in "Mathematical language", that is to promote the use of "proofs" at a very young age by walking their students through how to explain their thoughts in the syntax of math.

Jaclyn says

Well, this was excellent. My anger at Mathematics education in the states is melting into sadness and despair. When almost 20% of elementary school math teachers surveyed don't know the formulas for area and perimeter of a rectangle, we face a more deeply ingrained, entrenched, intractable problem than I ever could have imagined.

It also pained me to hear the Chinese teachers describe learning from their colleagues, solving problems together and spending time discussing pedagogy. If teachers here had that sort of free time and group dynamic, I wonder if they'd relish the opportunity to develop themselves, or instead, opt for an early homeward-bound journey.

Le sigh.

Laura says

For anyone who doesn't understand why our children are learning "new math", this is a must-read. I spent a Saturday morning intently reading this dissertation on elementary mathematics education. I was interested in this book as a homeschool parent who uses Singapore Math curriculum for my first grader.

Liping Ma's research shows the difference in how we teach math for a conceptual verses a procedural understanding. I had several aha! moments where I realized that my memory of certain mathematical processes were based on knowing the procedure to follow rather than a genuine understanding of the mathematical concepts. I would highly recommend this book to any parent who wants to help their child develop a greater conceptual understanding of basic math.
