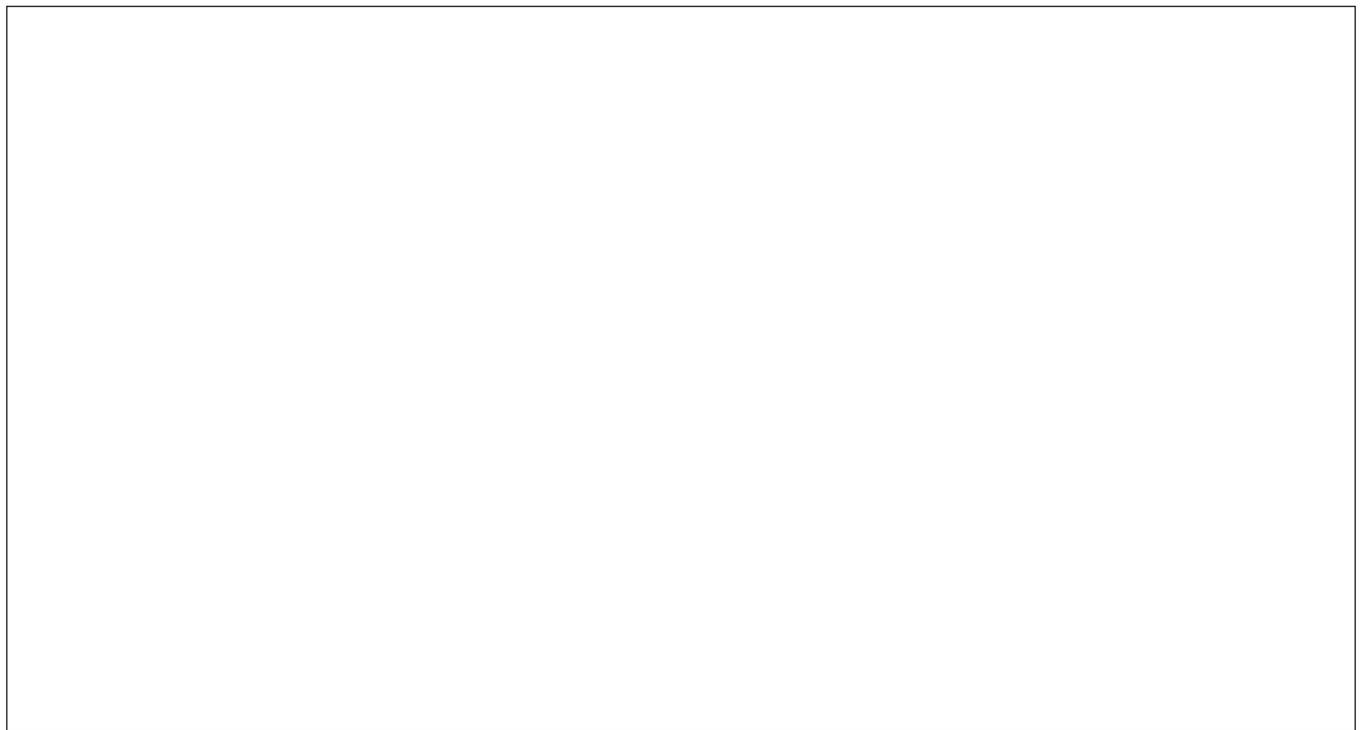


Math Wars 2:

It's the Teaching, Stupid!

In math classes, teachers often focus instruction on the formulas and processes needed to solve different types of problems but neglect to teach the concepts on which these tools are based. Before they can do this, Mr. Marshall argues, teachers themselves need to understand “understanding math.”



BY JOHN MARSHALL

PICTURE THE scene if you will. Sitting ahead of me in economy class is a mother with her young child. I am two rows back and cannot see them, but the conversation tells all. The game is counting, what I am not sure. Clearly pointing to something, Mother says, “One, two, three, four, five. Now you do it.” A little voice replies, “One, four, three, nine, two.” “No, no. It’s one, two, three, four, five. Try again.” “One, two, five, four, six,” is the response. “Come on now, you’re not trying. Let’s do this. One, two, three. Now you.” “One, two, three.” “Good girl, now, one, two, three, four.” “Four, two, five, one.” Mother is getting quite exasperated, at least judging by the tone of her voice, and the youngster is far

JOHN MARSHALL has been developing mathematics curricula for many years. He was involved in the production of the Minnesota K-12 Math Framework and has taught elementary school math methods classes at the University of South Florida, St. Petersburg.

from happy. I really feel this will end in tears, but I manage not to cry.

Sometime later, I found a certain confirmation of this style of teaching in a book that advocates something similar:

Counting with skill and understanding is an important problem-solving tool in mathematics. The activities in this chapter give your children many opportunities to count in unison, which will build on and reinforce the auditory pattern of the counting order. Children should start these activities by counting to one number beyond the point where they begin to have difficulty. When they become confident counting to this number in the sequence, one more number should be added to the sequence until the children build gradually to ten. There is no need to rush or push children ahead quickly to ten, for this pressure produces anxiety rather than learning.¹

Believe me, my fellow passengers were certainly feeling some anxiety. The tension was unbearable! You see, it was all rather rote. By the way, I take my definition of “by rote” from the *Oxford English Dictionary*, which defines it as “in a mechanical manner, by routine; especially by the mere exercise of memory without proper understanding of, or reflection upon, the matter in question.”

It seems that children exposed to this form of teaching are expected to use a concept before they have experienced it. Isn't this style of rote teaching an example of what Michael Battista says is common, is “ineffective,” and “seriously stunt[s] the growth of students' mathematical reasoning and problem-solving skills”?² Perhaps something similar was in Richard Copeland's mind when, writing about Piaget's work, he said that “counting is often the first mathematical idea taught to children. It should not be the first mathematical activity. . . . Classification is the basis for mathematical concepts and should come before counting.”³

I wonder how many of us have ever stopped to ask what “three” means to a young child. Remember, Mother pointed to one “thing” and said “three.” So let me invite you to pause for a moment and ask if you know what “number” is? Can you define “three”? I feel I am on safe ground asking about a definition, for, according to James Stigler and James Hiebert, “Lessons in the United States [seem] to place greater emphasis on definitions of terms and less emphasis on underlying rationale.”⁴ I must be clear, though, that I am not deni-

grating the knowing of “definitions” and related formulas. But, in a curriculum designed to foster understanding, our students really do need to know what these things mean, where they come from, and how they fit into the grand scheme of things we call mathematics, one of mankind's great intellectual achievements.

If it is true that our teaching style is as Stigler and Hiebert say, then we don't seem to have a good track record, even at a very basic level. “Many elementary and middle-grades children have difficulty with understanding perimeter and area. Often, these children are using formulas such as $P = 2l + 2w$ or $A = l \times w$ without understanding how that formula relates to the attribute being measured or the unit of measurement being used.”⁵ We also know that “understanding formulae and their appropriate use and retention is dependent both on earlier practical experiences and on a perceived need for and appreciation of this efficiency.”⁶ Somehow this failure to engage students' minds is missed, and, for many children, the understanding that undergirds the construction of a formula is bypassed. Persisting with a narrow style of teaching is, in my view, part of the problem.

So what is “three”? I try to pose this question to students in my methods class about halfway through my opening lecture on understanding “understanding” in mathematics teaching. This gives them time to discuss it during a break and perhaps to find a “three” to bring back to class. Perhaps! But no one ever does. I get a host of “three things” but never “three” alone. The most telling remark I got was: “Here I am in college classes to become a teacher, and I never knew what ‘number’ was. How did that happen?” You may well ask.

The problem, Thomas Post of the University of Minnesota reminds us, is that

number is an abstraction. No one has ever seen a number, and no one ever will. “Twoness” is an idea. We see illustrations of this idea everywhere, but we do not see the idea itself. In a similar way the symbol “2” is used to elicit a whole series of recollections and experiences that we have entailing the concept of two, but the squiggly line “2” is in and of itself not the concept.⁷

So here is the challenge. How do we teach young children about an abstract concept — and math is full of them — when they are at the concrete operational stage of their development and when a lot of us don't know what it is in the first place?⁸ Good advice is urgently required.

Somehow real things must become a way of modeling abstract ideas. Even great mathematicians who have defined “number” over the years have used “real things” in an attempt to make it clear to us. So why not for young children? Simon Singh attributes a definition of “three” to Gottlob Frege in 1884 that actually uses a familiar nursery rhyme:

One of Frege’s key breakthroughs was to create the very definition of a number. For example, what do we actually mean by the number three? It turns out that to define three, Frege first had to define “threeness.”

“Threeness” is the abstract quality which belongs to collections or sets of objects containing three objects. For instance, “threeness” could be used to describe the collection of blind mice in the popular nursery rhyme, and “threeness” is equally appropriate to describe the set of sides in a triangle. Frege noticed there were numerous sets which exhibited “threeness” and used the ideas of sets to define “3” itself. He created a new set and placed inside it all the sets exhibiting “threeness” and called this new set of sets “3.” Therefore, a set has three members if and only if it is inside the set “3.”

In the 1960s, an article in *Scientific American* defined “four” with an illustration using three-dimensional shapes. (See Figure 1 for a similar representation.) This definition seems to fit Frege’s words, particularly where the text says, “The outer frame is not closed at the right because membership in this class is not re-

stricted to the examples shown.”¹⁰ The concept of fourness extends beyond the shapes shown, just as threeness covers more than those “things” that my students bring back to class.

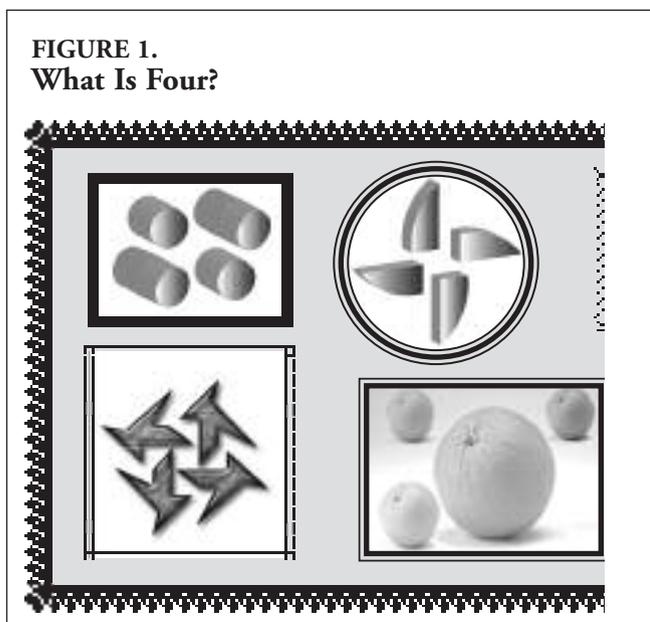
How did you get on with your definition? My students were not as far off the mark as one may think, for, although individually they did not get “three,” collectively they did, for “three” was the commonality linking all the sets (of three things) that they brought back! Interestingly, we could all touch the things but not the link between them. That was as close as we could get to modeling an abstraction.

My students’ collections were revealing, for along with three Snickers bars we had three M & Ms, which made us realize that number was independent of size, shape, color, texture, position, taste, etc. The students’ display captured the notion of the conservation of number because they had large things, small things, things close together, and things spread every which way. Conservation is about the invariance of a set, which always has the same “number of members” whatever the configuration and however it looks. Children need to understand this idea, for they do not know “number” until they do. Indeed, they will not “know” number if their experiences are limited by such activities as a card game, a domino game, or a wall display, where “five” has a fixed shape, is colored red, and is depicted solely by a squiggly line such as “5.”

When it comes to teaching a curriculum focused on “understanding,” what does all of this mean for the children? What does it look like in the classroom? Not the same old, same old surely? We need to design our teaching so that students can take the concepts of mathematics forward and apply them to each new situation they meet. Remember, too, “conceptual structures are richly interconnected bodies of knowledge. It is these which make up the substance of mathematical knowledge stored in long-term memory.”¹¹ So it’s the interconnections.

Teaching mathematics with understanding means creating experiences in which these interconnections can be made because, without them, there would be a real danger that questions put in isolation would make the learning process rather piecemeal and incoherent. What is more, the low retention of fragmentary knowledge is well attested, which again does not help when we need to use the math we learned yesterday sometime far off in the future.¹² It is vital, therefore, that students be offered a variety of models — real models — that take them from the reality of their world

FIGURE 1.
What Is Four?



into the world of abstract mathematics and, where appropriate, back again.¹³ In terms of understanding about “three,” Frege is saying to me that students need to make the connection between three cars, three cups, three necklaces, and three of anything else in order to understand the concept. Experiencing “threeness” allows the brain to take the idea of “three” on board. It is interesting to note that Liping Ma takes up this theme in *Knowing and Teaching Elementary Mathematics*, when she suggests that elementary school teachers need a profound understanding of mathematics in order to teach for understanding:

A teacher with profound understanding of mathematics is not only aware of the conceptual structure and basic attitude of mathematics inherent in elementary mathematics but is able to teach them to students. The first-grade teacher who encourages students to find what five apples, five blocks, and five children have in common, and helps them to draw the concept of 5 from these different kinds of items, instills a mathematical attitude — using numbers to describe the world.¹⁴

I would suggest that teachers need to develop not only such a profound understanding of mathematics but also a corresponding understanding of how children learn. Then we will be able to debate both how children learn mathematics and ultimately how we teach.

So let me add to this debate and offer a “lesson” I found in the Minnesota K-12 Mathematics Framework that has children classifying everyday objects.¹⁵ Sorting and talking is the name of the game. Children sort their collections according to certain attributes and match their sets in one-to-one correspondence, with more in some sets than in others. Models are made with everyday “things.” Clear images are created in the mind.

On another day, the teacher contrives a situation in which all the children’s sets match: “I have as many trains as boats; I have as many boats as planes; I have as many. . . .” Just as in my methods class, anything that belongs in this new collection, where the elements match one-to-one, will have the same number.

The Minnesota children are then asked to look around them and create other sets that will match those that the teacher has provided because “understanding in mathematics implies an ability to recognize and make use of a mathematical concept in a variety of settings, including some which are not immediately familiar.”¹⁶ In effect, the children are moving into the open-ended part of Figure 1, and while they are experiencing “three,” the teacher can teach them how to write the number’s name, “three,” and its numeral, 3.

The Minnesota children and my methods students made the connection between the “sameness” of the “things” in their collections. They also described that sameness. In teaching for understanding, students experience the concept before they move to the symbolism. And they truly need to see “three” all over the place before they are ready for abstract symbols. Throughout the episode on the airplane, I felt that we passengers were witnessing an effort to reverse the order: to teach the symbolism before the concept. Throughout that whole episode, as the mother counted to five, touching one object at a time, I wondered how the child was connecting with the concept “three” — Frege’s “three.”

The concept of “three” is captured in a wall display (Figure 2) that also includes the concepts of 2, 1 (shown), 5, and 4 in random order. Children come to understand these numbers as complete entities before

counting. Counting comes after the numbers have been placed in order and when children know *why* three is more than two. Matching a set of three (cups) with two (saucers) in one-to-one correspondence will show which set has more members. This indicates that 3 comes after 2 in the order of things. It will also help later with the concept of subtraction, in which students need to understand that the operation is more than just “take away.” Placing charts such as those in Figure 2 in the classroom will remind children what “number” is and why 3 comes after 2, etc.

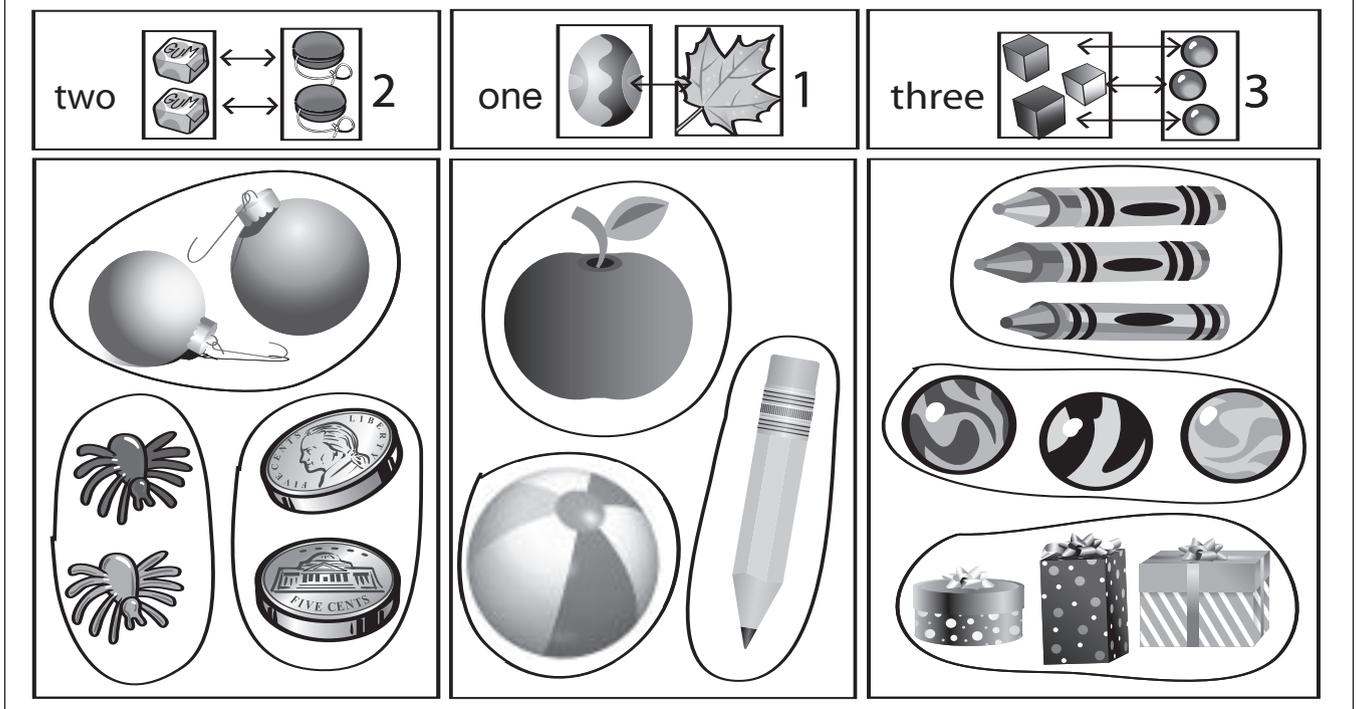
We know that young children can subitize — perceive small numbers of objects immediately, without counting — for it seems it is the natural thing for the brain to do.¹⁷ *Principles and Standards for School Mathematics* reminds us that children “may look at a small group of objects . . . and recognize how many, but they may need to count a group of ten or twelve objects to find the total.”¹⁸ The failure to exhibit this ability is what researchers studying dyscalculia — “a crippling inability to handle numbers,” the mathematical form of dyslexia — are currently looking at. In September of 2003, Brian Butterworth, a professor of cognitive neuropsychology at University College, London, gave a paper at the British Association for the Advancement of Science on the problems of dyscalculia. I men-

tion it here because he suggested that there is “a link between dyscalculia and a primitive number sense possessed by human beings and animals that enables them to make instant assessments of the number of objects in a group without having to count.”

Dyscalculia does not stem from ineffective teaching. However, effective teaching is about offering the developing brain high-quality information based on real experiences, for then it responds well. That is our great challenge. It will take time to get things right, and time is not on our side — at least for the children who are in school now. The evidence before us is that continuing to do what we have been doing will be harmful. We surely know this by now. Yet we keep on doing the same things. Why? How many of our students can’t wait for our lessons to end? I expect my young co-passenger, and indeed her mother, could not wait to get off the plane. I know I couldn’t.

The mother on my flight was doing what she was doing not because she was a “bad” mom but because that was the norm. It is what we do. Indeed, on my desk right now is what I call my *Standards Compatible All-Singing-All-Dancing Beginning Math* textbook, which asks on page 1 (of 548), “How many children do you see [in the picture]?” The answer: 15; then 1-2-3 comes afterwards! (If a student can count to 15,

FIGURE 2.
The Concept of Number



why bother with 1-2-3?) Mothers cannot all be expected to know what Piaget and Copeland suggest, but teachers and students in math methods classes can and should. My fellow passenger and her little friends should be encouraged to see number as Frege did and to “just know” beginning numbers because her teacher’s math methods class and textbook have highlighted the research. Her teacher needs to know that children must feel “at home” with “general number properties such as the invariance of the number of objects in a set under rearrangements.”¹⁹ They must know, too, “that when counting a set, the same final number is reached irrespective of the order in which the objects are taken.”²⁰ And all of us, including parents, need to have confidence that what children “interact with” reflects this research. Do the materials children handle really offer “a whole series of recollections and experiences” that they have involving the concept of number?

We must not forget the actual teaching experience children have either. High-quality lessons are what students expect at school. But in order to deliver high-quality lessons, teachers and those who support them need to know both math and how children learn. The goal truly is understanding understanding. It is the teaching.

LET ME dwell, for a moment, on some of the strange things that I see in the name of mathematics teaching that really have no place in an understanding curriculum. Busy teachers don’t get much chance to see what is happening in other classrooms, so perhaps a look at some material that concerns me will provoke some thought, for we need to turn rather too many negatives into a host of positives for our students. Sadly, in this case, two negatives don’t make a positive!

It is all very well for researchers to say that students don’t understand the area and perimeter of a rectangle, but where does that come from? What of their teachers? Do they have the profound understanding they need? I have my doubts, especially if they have been brought up to believe that the area of a rectangle is actually “length times width.” One cannot multiply a length by a length, even though the methods book I use tells me I can: “Now we are multiplying two lengths to get an area.”²¹ What we are really doing when we measure the area of a rectangle is finding out how many square units will “cover” it. We are measuring an area with an area. We are, in fact, count-

ing “square units,” and multiplying can be a quick way of counting. So it helps to know how many square units are in a row and how many repeated rows there are. Taking a “5 by 4” rectangle as a model, we have one square unit, five times in a row — that is, 1×5 . (Notice that I “see” the square unit first.) Then, be-

High-quality lessons are what students expect at school. But in order to deliver high-quality lessons, teachers and those who support them need to know both math and how children learn. The goal truly is understanding understanding. It is the teaching.

cause we have four rows, we have all that four times. So the formula looks like $(1 \times 5) \times 4$, or generalizing $(1 \times l) \times w$, where 1 represents the “square unit,” l represents the *number* of square units in the row, and w represents the *number* of repeated rows of square units. Of course, because 1 creates “no change” when multiplying (it is the identity element for multiplication), it all boils down to the short form $A = l \times w$. It might be more helpful if we didn’t use l and w because of the past, but in an understanding math curriculum the children have a feeling for the formula, they know where it comes from, and they know that they are not really multiplying lengths.²²

Stigler and Hiebert give a useful analysis of some scary data in *The Teaching Gap*. Their urging of “lesson study” as a way forward has much to commend it, but strong leadership has to be there — and there in spades. To highlight their concern about the poor-quality experiences that U.S. students receive, they cite a lesson involving finding the sum of the interior angles of a hexagon. It included the following discourse:

Mr. Jones: I still have six angles. There is a formula, and we are going through this after spring break [How many times did I hear that when I was in school?], but I will give you a hint right now. If I take the number of sides, and I subtract 2, and I multiply that number times one hundred and eighty degrees, that will tell me how many degrees these add up to. How many sides in this figure? (Pause). Six. Right? Number of sides subtract two, gives me what?

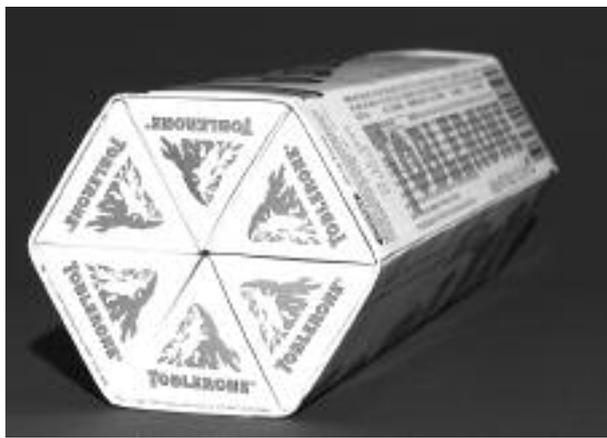
Students: Four.

Mr. Jones: Four. What is four times one hundred and eighty degrees?

Jacquille: Seven hundred and twenty.²³

Clearly, the teaching style here requires that students merely exercise their memories, “without proper understanding of, or reflection upon, the matter in question,” for the matter in question has to be the *creation* of the formula. When I first read this account, I wondered whether my box of real-world chocolate (see Figure 3) might give a “concrete to abstract” model that would lead students to see that the hexagon problem may have more to do with triangles and the angles contained therein than with sides. The sum of the angles in a triangle equals 180 degrees, and there are six “triangles” in the “hexagon,” but we are interested only in the angles formed by the edges of the hexagon. Therefore, the angles at the apex of each triangle are surplus. The total we are concerned with is $(180 \times 6) - 360$, which is indeed 720! Generalizing comes later from $180 \times n - 360$, which, having done the algebra, is Mr. Jones’ $180(n-2)$. Tasty!

FIGURE 3.
A Sweet Example of the Number of Triangles In a Hexagon



An understanding curriculum would challenge the students to actually make the box shown in Figure 3 and in doing so would provide them with a good deal of real-world geometry. And dare I mention that a phrase such as “and I multiply that number times one hundred and eighty degrees” is not sound mathematics either? In an understanding curriculum, the language of mathematics, together with its symbolism, has a certain precision that is compatible with concept formation. Indeed, language enhances concept formation.

The methods textbook I was once “recommended” has a section on “The Beginning of Number Concepts.” It starts with counting and says, “When children count they have no reason to reflect on the way one number is related to another.” Well, I believe they should have a reason because connecting with “neighboring numbers” is what understanding counting is about! The book also claims that “it can be a very rewarding effort to help students connect their number ideas to the real world.” Yet 16 of the 21 illustrations of number concepts use dots. No trains and boats and planes here, just real-world dots. Is this really the way forward? In a truly understanding mathematics methods book, the line should read: “It is essential that students connect their number ideas to the real world.”

Sadly, I do not feel confident that these examples are isolated instances, for in *The Teaching Gap*, Stigler and Hiebert devote 200 pages of analysis to the poor-quality math teaching many American students get when compared with their counterparts in Japan and Germany. After having analyzed a lot of lessons, they report that the percentage of lessons in the U.S. that were rated as having a high-quality mathematics content was zero.²⁴

It is not just “lessons” where the high-quality mathematics content is zero. I found a set of “counting dominoes” in which only three tiles out of 28 can be played, surely not evidence of high quality. The best-selling trivial-pursuits-type game an educational supplier sent me as a model for me to emulate used cards with number sentences such as $13 - 11 \times 9 = 18$ (when of course it should be -86). And I suspect that every elementary school in the country has its share of “thick circles,” when there are really no such things,²⁵ though I was once told where I could buy some! I hope too that my airline mom doesn’t buy the book I just did, which tells me that a carrot is a triangle and an apple, a circle. (She will not get an answer if she complains to the publisher.) We seem to be tooling up for failure, for poor math sells — or so I am repeatedly told. A profound understanding of elementary mathematics will develop only when all involved are willing to embrace fundamental change.

The bottom line is that research has shown that things our brain does not understand are more likely to be forgotten.²⁶ It is part of our makeup.

So, for mathematics teaching to be effective, major changes are essential: a new generation of materials must be created that are truly reality-based, and new attitudes must be adopted by everyone involved in the

mathematical education of our children. Teaching for understanding is not easy, especially when one has been brought up relying on rote memorization. But it is something we need to take into our belief system if our children are to have a chance.

And there is no magic wand. It can be quite a shock to the system that some old beliefs may be challenged as the past gets in the way of the future. On the other hand, as the fog clears, the rewards will be tremendous, and at last math will be a class worth going to. More to the point, for those teachers who take the plunge, there is a noticeable growth in confidence. They cannot wait to start teaching for understanding. But — and there is always a but — they do need support, and support they can have confidence in. That cannot be said too often. Teachers need guidelines that truly advocate an understanding approach, they need contemporary materials that help rather than hinder the learning process, they need professional support that really understands understanding mathematics, they need to have assessment procedures that support their desire to develop a profound understanding of elementary mathematics as they teach, they need to be free of excessive paperwork that takes time from lesson preparation, and they need a supply of delightful students. We probably have only the final one of these six at present. When all those pieces are in place, we'll be able to sing with Louis Armstrong that children know "more than I'll ever know." I wish.

1. Mary Baratta-Lorton, *Mathematics Their Way* (Menlo Park, Calif.: Addison-Wesley, 1976), p. 90.
2. Michael T. Battista, "The Mathematical Miseducation of America's Youth: Ignoring Research and Scientific Study in Education," *Phi Delta Kappan*, February 1999, p. 426.
3. Richard W. Copeland, *How Children Learn Mathematics: Teaching Implications of Piaget's Research* (New York: Macmillan, 1970), p. 32.
4. James W. Stigler and James Hiebert, *The Teaching Gap* (New York: Free Press, 1999), p. 85.
5. *Principles and Standards for School Mathematics* (Reston, Va.: National Council of Teachers of Mathematics, 2000), p. 46.
6. A. W. Bell, J. Costello, and D. Küchemann, *A Review of Research in Mathematical Education* (London: NFER-Nelson, 1983), p. 162.
7. Thomas Post, "The Role of Manipulative Materials in the Learning of Mathematical Concepts," in Mary Montgomery Lindquist, ed., *Selected Issues in Mathematics Education* (Berkeley, Calif.: McCutchan, 1980).
8. "Mathematics itself is about exact and precise ideas and 'concepts,' about 'abstractions,' which are in our minds. Although these concepts can be applied to our real world, and things in the real world can help us to think about mathematics, the abstractions are not things we can see and touch. Mathematics is in the mind, in our thoughts." Sir Wilfred Cockcroft and John Marshall, "Educating Hannah: It's a What?," *Teaching Children Mathematics*, February 1999, p. 328.
9. Simon Singh, *Fermat's Last Theorem* (London: Fourth Estate, 1997), p. 150.

10. *Mathematics in the Modern World: Readings from Scientific American* (San Francisco: W. H. Freeman, 1968), p. 190.
11. Committee of Inquiry into the Teaching of Mathematics, *Mathematics Counts* (London: H.M.S.O., 1982), p. 71.
12. Bell, Costello, and Küchemann, p. 7.
13. If a young soccer player scores 17 goals in 20 games, then his scoring average is 0.85 goals per game. The problem is real, but the average is abstract, as one cannot score 0.85 goals in a real game.
14. Liping Ma, *Knowing and Teaching Elementary Mathematics: Teachers' Understanding of Fundamental Mathematics in China and the United States* (Mahwah, N.J.: Erlbaum, 1999), p. xxiv.
15. *Minnesota K-12 Mathematics Framework* (St. Paul: SciMath^{MN}, 1998), p. 8.
16. Committee of Inquiry into the Teaching of Mathematics, p. 68.
17. A recently published book reports that "Antell and Keating's research shows that, when each of us was just four days old, we were able to distinguish between collections of two and three objects that we saw. . . . We certainly have the beginning of a sense of twoness and threeness by the time we are six to eight months old." Kevin Devlin, *The Math Instinct* (New York: Thunder's Mouth Press, 2005), p. 12.
18. *Principles and Standards for School Mathematics*, p. 80.
19. Bell, Costello, and Küchemann, p. 98.
20. *Ibid.*
21. John A. Van De Walle, *Elementary School Mathematics: Teaching Developmentally* (New York: Longman, 1994), p. 121.
22. Research shows that "formulae and their appropriate use and retention" depend "both on earlier practical experiences and on a perceived need for and appreciation of this efficiency." Bell, Costello, and Küchemann, p. 162.
23. Stigler and Hiebert, p. 45.
24. *Ibid.*, p. 65.
25. Cockcroft and Marshall, op. cit.; and Deirdre Dempsey and John Marshall, "Dear Verity, Now I'm Getting into Shape!," *Phi Delta Kappan*, April 2002, pp. 606-11.
26. Kenneth Lovell, *Educational Psychology and Children* (London: University of London Press, 1958), pp. 118-26; H. Maddox, *How to Study* (London: Pan, 1976), p. 56; *Mathematics Counts*, p. 70; Lawrence F. Lowery, *The Biological Basis of Thinking and Learning* (Berkeley: Regents of the University of California, 1998); and *Principles and Standards for School Mathematics*. 

File Name and Bibliographic Information

k0601mar.pdf

John Marshall, Math Wars 2: It's the Teaching, Stupid!, Phi Delta Kappan, Vol. 87, No. 05, January 2006, pp. 356-363.

Copyright Notice

Phi Delta Kappa International, Inc., holds copyright to this article, which may be reproduced or otherwise used only in accordance with U.S. law governing fair use. MULTIPLE copies, in print and electronic formats, may not be made or distributed without express permission from Phi Delta Kappa International, Inc. All rights reserved.

Note that photographs, artwork, advertising, and other elements to which Phi Delta Kappa does not hold copyright may have been removed from these pages.

Please fax permission requests to the attention of KAPPAN Permissions Editor at 812/339-0018 or e-mail permission requests to kappan@pdkintl.org.