One Step Ahead of the Everyday Math Train Wreck

by Barry Garelick

The first math tutoring session with my daughter and her friend Laura had ended. I sat in the dining room, slumped in my chair. "You look sick," my wife said.

"I am," I said.

My daughter—subjected to the vagaries of Everyday Mathematics (1), a math program her school had selected and put in effect when she was in the third grade—was having difficulty with key concepts and computations. She was now in 6th grade, and with fractional division, percentages and decimals on the agenda, I wanted to make sure she mastered these things. So, near the beginning of 6th grade, I decided to start tutoring her using the textbooks used in Singapore's schools. I was familiar with the books to know they are effective (2). To make the prospect more palatable, I suggested tutoring her friend at the same time, since Laura's mother had mentioned to me that her daughter was also having problems in math.

I figured I would start with the fourth grade unit on fractions which was all about adding and subtracting fractions, which they had already done, and then move rapidly into fifth grade, and start on the rudiments of multiplication. "This'll be easy," I thought. "They've had all this before in 4th and 5th grades."

We only made it into two pages of text in the fourth grade book. I came to find out that despite their being in 6th grade, the concept of equivalent fractions (1/2 = 2/4 = 3/6 and so on) was new to them. This was the beginning of my attempt to teach my daughter what she needed to know about fractions while trying to stay one step ahead of the train wreck of Everyday Math (EM).

Train Wreck Defined

To understand why I refer to Everyday Math as a train wreck, I need to provide some context. First of all, some information about me: I majored in mathematics and have been working in the field of environmental protection for 36 years. I not only use mathematics myself, but I work with engineers and scientists which requires a fairly good proficiency in it.

Everyday Mathematics was developed at the University of Chicago through a grant from the Education and Human Resources Division of the National Science Foundation in the early 90's. It has been implemented in many public schools in the U.S. Parents have often protested its adoption and in some cases have prevented it from being used, or succeeded in getting the program halted. For example, after a local parent group put pressure on the Bridgewater-Raritan Schools in New Jersey, a very comprehensive program evaluation was conducted (http://www.brrsd.k12.nj.us/files/filesystem/Math%20Evaluation%20Report.pdf[1]) which resulted in a 9-0 school Board vote to replace Everyday Mathematics with a more balanced and traditional program, HSP Math by Harcourt School Publishers. In other cases (such as in Palo Alto, California most recently), it has been adopted despite protests from parents.

The Singapore math texts are part of the Primary Mathematics curriculum, developed in 1981 by Curriculum Planning & Development Institute of Singapore. Singapore's math texts have been distributed in the U.S. by a private venture in Oregon, singaporemath.com, formed after the results of the international test TIMSS spurred the curiosity of homeschoolers and prominent mathematicians alike.

As I mentioned, my daughter's school in Fairfax County, Virginia started using the program when she was in third grade. By fourth grade, I was seeing some of the confusion caused by EM's alternative algorithms. This aspect of EM has been written about extensively so I won't dwell on it here [*i, ii, iii*] except to say I wanted to make sure my daughter understood the standard algorithms for two-digit multiplication and for long division. Her teacher insisted they use the alternative algorithms offered by EM; she did not teach the standard algorithm for long division. Some of the teachers at her school offered tutoring services, so we hired one of them to teach her the standard algorithms.

The teacher/tutor did as we instructed and after four sessions, my daughter was excited to show me how she could do long division. She wrote out a long division problem but got stuck along the way when she didn't know the answer to 28 divided by 7. Long division is predicated on students knowing their multiplication facts. My daughter was not alone in this; many of the students in her class did not know them. Perhaps her tutor had discussed what to do in such instances. It was apparent that whatever she told her was not to brush up on her facts, but rather go back to first principles, since my daughter was now drawing 28 little lines on the sheet of paper and grouping them by 7's. I decided to inquire.

"WHAT ON EARTH ARE YOU DOING?" I asked. My daughter began to cry.

I felt bad about yelling. Later, my wife, daughter and I sat down and reached an agreement. It was too expensive to keep on having her tutored– I had spent $200 so far on tutoring and really could not afford any more. We would therefore halt her tutoring and I would take over provided that I would not yell.

I helped her on an ad hoc basis. If she needed help, I would step in. The problem is that when she needed help, it was generally too late, and I would end up having to do damage control. One problem I was having was that EM does not use a textbook. Students do worksheets every day from their "math journal" a paperbound book that they bring home. Without a textbook, however, it is not always apparent what was taught—particularly when the student doesn't remember. Any explanation that a student has received about how to solve such problems is done in class. The technique is contained in the Teacher's Manual, but that is something neither students nor parents have. There is a student's reference manual, a hardbound book containing topics in alphabetical order and which can provide some guidance, but does not necessarily cover what was said in class. Thus, there is no textbook a student (or parent) can refer to go over a worked example of the type of problem being worked. Worse, sometimes problems are given for which students have no prior knowledge or preparation. They appear to be reasonable problems—it is just not evident to the parent who steps in to help the struggling child that they have had little or no preparation for such problems. Then there is the issue of sequencing, or lack thereof—which I will discuss later.

By the time my daughter was in fifth grade, she would get a problem like 8÷0.3. They had not had fractional division, and limited work with decimals—certainly nothing like this problem before. A typical dialogue would then proceed as follows:

Me: What did the teacher say about how to solve this?

Daughter: I don't know.

Me: Whattya mean you don't know? You were there weren't you?

Daughter: I don't know what he said; he just said do the problems.

Me: Well, how do they expect you to do this? You've never had anything like this before. SO OF COURSE THEY GIVE YOU SOMETHING THAT YOU CAN'T DO AND YOU'RE SUPPOSED TO FIGURE IT OUT?

Wife: (offstage) what's the yelling about?

Daughter: It's OK, he's not yelling at me.

Me: I'm not yelling at her.

Wife: (offstage) I heard yelling. Are you getting mad at her?

Daughter: He's not getting mad at me; he's mad at the book.

My daughter's fifth grade teacher shared my disdain for EM and supplemented it heavily with photocopies of pages from an older textbook. I told him once in an email that I was not happy with EM and asked him his opinion. I've asked other teachers this question and they usually chose not to answer—perhaps out of fear for their jobs. I was surprised therefore when he responded: "I totally agree with you on everything you said about Everyday Math. It has been very difficult for me to use the book."

Despite his knowledge and good teaching, there was still lack of a textbook and he was still consigned to the pacing and sequence of EM. I believe these factors contributed to the lack of knowledge about fractions exhibited by my daughter and Laura.

The Long March to Fractional Division

Knowing that in 6th grade, they would learn fractional division, as well as decimals and percents, I feared a train wreck if I didn't get to my daughter first. Given how little they knew about fractions during the first lesson, I felt that my fears were justified.

Fortunately, things progressed nicely with the two girls after that first lesson. But I only had about four weeks before they hit fractional division—not a lot of time. Therefore, I decided to teach each chapter on fraction in the Singapore Math, from 4th grade to 6th grade textbooks in a concentrated burst. Although I really should have started all this back in 4th grade, doing it this way had an unexpected benefit: they saw almost immediately the connections between multiplication and division of fractions. This was no coincidence—the curriculum is very carefully sequenced. And while fractional division isn't presented formally until the 6th grade, students are working on aspects of fraction division long before they reach the 6th grade. By the time students reach the 6th grade unit on fraction division, they have done hundreds of these problems leading to an understanding of the meaning of and connection between fraction multiplication and division.

The heavy lifting with Singapore worked well; when they got to EM, it was a review. It was almost anticlimactic. It was a one page worksheet asking questions such as "How many ¾ inch segments are there in 3 inches?" After four such questions, the text presented a formula in a box in the middle of the page, titled "Division of Fractions Algorithm". The algorithm was stated as a/b÷ c/d = a/b * d/c. Unlike in Singapore Math, there was nothing to connect any invert and multiply relationships to previous material. In fact there was nothing that appeared to lead up to this—just a rule to be memorized despite EM's pledge to teach "deep understanding". As I and many other parents I've spoken with have found, EM lacks the sequencing to pull it off; and that is the crux of the train wrecks that were to come.

The Spiraling Train Wreck: Numbers with Points in Them

Despite the victory with fractional division, the following week's tutoring session left me slouched in my chair with my hand over my eyes.

"You look sick," my wife said.

"I am," I said. "Just when you think everything is going great, it isn't."

I had planned to focus on word problems in fractional division to cement in the concept, but apparently the day's math lesson at school had confused Laura, and before my lesson could begin, she asked me the following question:

"I'm confused about something," she said. "How do you get from a number on top and number on the bottom of a line into a number that has a point in it?"

I had her repeat the question a few times before I understood she was asking how you convert a fraction to a decimal. Now, Laura was bright and she knew what a numerator and denominator were, and what a fraction was, but apparently the EM lesson they were working on sprung this on them without warning

I wasn't planning on teaching decimals that day, but seeing that the train wreck of conversion of fraction to decimal was upon us, I took this as a cue. Singapore presents conversions for the first time in the 4th grade text [*iv*] showing 6 dimes divided into 3 groups yielding 2 dimes per group, which is expressed first as 6 "tenths" divided by 3 is 2 "tenths". They then take it to the next step: 0.6÷3 = 0.2. After a few more similar problems, Singapore then introduces 2÷ 4 and shows a boy thinking "2 is 20 tenths."

At the end of the unit they are solving problems like 2.4÷ 6, 3 ÷ 5 and 4.2 ÷7 as well as non-terminating decimals such as 7 divided by 3. What is striking about this lesson is that while its focus is decimal division, the lesson implicitly teaches how to convert fractions into decimal form by virtue of students having learned earlier that fractions are the same as division. That is, they have learned earlier that 1÷ 4 is the same as ¼. The lesson on dividing decimals was situated in the context of fractions—and treating fractions (i.e., tenths) as units—a unifying theme that extends throughout the Singapore series.

I've thought about why Laura could not understand the lesson at school, to the extent she could no longer recognize what a fraction was. I believe it is because while Singapore situates decimals in the context of fractions, EM situates decimals in the context of the unfamiliar. The EM program is predicated on the theory known as the "spiral approach":

"The *Everyday Mathematics* curriculum incorporates the belief that people rarely learn new concepts or skills the first time they experience them, but fully understand them only after repeated exposures. Students in the program study important concepts over consecutive years; each grade level builds on and extends conceptual understanding." [*v*]

This does in fact make sense considering that for most people a particular concept or task starts to make more sense after they have moved on to the next level. But this phenomenon occurs when there is mastery at each previous level. For example, I became fairly good at arithmetic and developed a deeper understanding of it after I took algebra; I fully understood analytic geometry after calculus and so on. Each previous bit of learning seems that much more apparent at the next level of understanding.

In EM, however, students are exposed to topics repeatedly, but mastery does not necessarily occur. Topics jump around from day to day. Singapore Math's very strong and effective sequencing of topics is missing in Everyday Math. While Singapore develops decimals by building on previous knowledge of fractions, in Everyday Math, students are presented with fractions and decimals at the same time. The topic of conversion of fractions to decimals occurs in the fourth grade in the context of equivalent fractions, and is called "renaming a fraction as a decimal". The "Student Reference Manual presents fractions that can easily be expressed as an equivalent fraction with a denominator of a power of 10 such as ½, or ¾. For fractions that cannot be directly expressed with power of 10 in the denominator, the Student Reference Manual provides the following instruction: "Another way to rename a fraction as a decimal is to divide the numerator by the denominator. You can use a calculator for this division. … For 5/8 key in: 5 ÷ 8; "enter"; Answer: 0.625." [*vi*]

It is not surprising then that Laura would fail to see what was going on. Without knowing what the connection was between fractions and decimals, the fraction ceased being a fraction in her mind and was just a number on top and a number on the bottom with a line in between. And somehow that strange looking number got transformed into a number with a point in it.

What the Casual Observer Doesn't Know

A casual glance at Everyday Math's workbook pages does not reveal that there is anything amiss. The problems seem reasonable, and in some cases they are exactly the same type given in Singapore Math. What the casual observer doesn't know is what sequencing has preceded that particular lesson, nor how that lesson is conducted in class. What is supposed to happen is that students are given a series of problems to work (in small groups). The Teacher's Manual advises teachers to monitor students as they work through the worksheet and look to see if students can answer certain key questions. If a student cannot, it is an indication that the student needs more help. This means "reteaching". Reteaching amounts to having students read about the particular topic of concern in the Student Reference Manual.

If the lack of proper sequencing, lack of direct instruction, lack of textbook and lack of mastery of foundational material prevents a student from making the necessary discoveries, he or she can be "pulled aside" and given material to read. So teachers are left with a three ring circus of kids getting it, kids not getting it, and are expected to "adjust the activity" as needed.

By the time EM gets to 6th grade, the workbooks are loaded with Math Boxes—the term for worksheet review sessions that come in the midst of a particular unit and consist of a mixture of problems from past years in the hope that the kids will finally master the material. Students get ever increasing amounts of Math Boxes. The expectation is that the nth time through the spiral is the charm. With EM, every day is a new train wreck of repeated partial learning.

Connecting Home with School

The danger of an "after schooling" program such as I was conducting is a tendency for the students to think of the math learned at home to be different or unconnected with the math learned at school. My goal of staying one step ahead of train wrecks worked to get to the topics first, so that by the time they got to it in school, they had seen it before. This was difficult since I was held hostage to EM's topsy turvy sequencing and occasionally was forced to tackle things like geometry that came out of nowhere. All in all, the crash course that I cobbled together on fractions provided the proper framework to then work with Singapore Math's lessons on percents, ratios, proportions and rates. The rest of the semester came without undue problems and both girls got A's in the class I'm happy to say.

I've told this story to many people since it happened—mostly people who have asked me what to do when their school has a problematic math program. My last retelling was to my wife; it's a recurrent theme in our house. We were reminiscing about when I had our daughter's toy blackboard set up in the dining room, and I was teaching her and Laura the math they weren't learning at school.

There was no need for me to finish the conversation, because the conclusion is always the same: Poorly structured math programs are not fair to students, parents or teachers. It is unfair to students because they are essentially attending another class after a fully day in addition to finishing their homework for school. It is unfair to parents who have to either teach their kids or hire tutors—and are held hostage to the school's math program whether they like it or not. And it is not fair to teachers who are expected to teach students based on an ineffective and ill-structured program. Through no fault of the teachers, math taught via EM is math taught poorly. It is by no means easy to teach math correctly. But it is even harder to undo the damage by math taught poorly.

Many teachers do not realize that they have been given an unenviable and impossible task. In fact, I have spoken with new teachers who speak of EM and other poorly conceived programs in glowing terms, speaking of them as leading to "deeper understandings of math." Some have said "I never understood math until I had this program." But it is their adult insight and experience that is talking and creating the illusion that the math is deep. Children cannot make the connections the adults are making who already have the experience and knowledge of mathematics.

Through my experience teaching my daughter and her friend, I have come to believe that an essential requirement of textbooks is that they teach the teachers. This may happen to some degree with EM, but based on my experience with the program, not much gets transferred to the students. With Singapore Math or any well structured and authentic mathematics program, both teachers and students greatly benefit.

Shortly after this experience, I began taking evening classes at a local university to obtain certification to teach math after retirement. I have no illusions—I'm told that it isn't easy. I'm not out to save the world—just to educate one child at a time. That said, I will remain forever grateful to my daughter and Laura for having taught me so much about fractions.

References:

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[*iii*] Clavel, M. (2003). How not to teach math. *City Journal,* March 7. http://www.city-journal.org/html/eon_3_7_03mc.html[4]

[*iv*] Singapore Math 4A

[*v*] Everyday math; Education Development Center; Newton MA; 2001. Available

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[*vi*] University of Chicago School Mathematics Project; 2004. *Everyday mathematics. Student reference book. 2002.* SRA/McGraw-Hill; Chicago (p. 59)

Barry Garelick

Barry Garelick has written extensively about math education in various publications including The Atlantic, Education Next, Educational Leadership, and Education News. He recently retired from the U.S. EPA and is teaching middle and high school math in California. He has written a book about his experiences in ed. school, student and substitute teaching: "Letters from John Dewey/Letters from Huck Finn".

Links

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