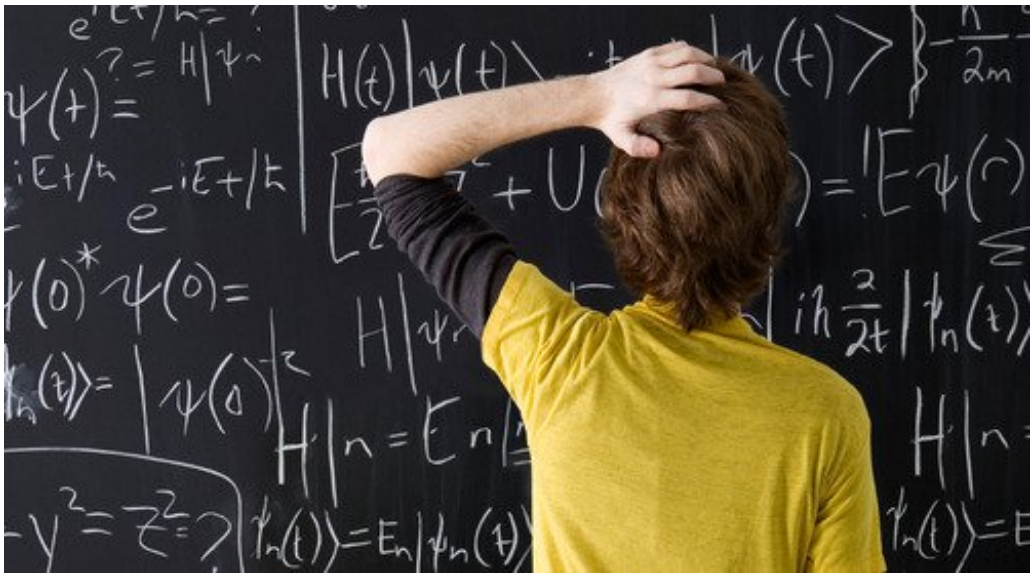
How Teacher Prep Programs Can Help Teachers Teach Math Conceptually

blogs.edweek.org/teachers/teaching_now/2017/07/learning_how_to_teach_math_conceptually.html

Madeline Will

7/10/2017



Future teachers are likely to teach as they were taught—which can be problematic, researchers wrote in a recent study, "because most teachers experienced school mathematics as a set of disconnected facts and skills, not a system of interrelated concepts."

But even when prospective teachers are taught to teach math conceptually, a good content knowledge base is still important, the study found.

Conceptually understanding math concepts and practices is one of the key emphases of the common core, but few preservice programs focus on a deep learning of specific math content. Elementary math teachers have had to learn how to move away from "teaching tricks" and relying on formulas in the past few years.

In a study published in the Harvard Educational Review, three researchers—two from the University of Delaware and one from the University of Pittsburgh—observed six first-year elementary teachers who graduated from the same teacher education program at the University of Delaware. These teachers had been taught to teach math conceptually, so the researchers observed each teacher teaching two lessons: one on a math topic that they learned in teacher preparation, and one on a math topic that was not addressed in their program. (Of course, this is a tiny sample size, so the results should be intrepreted with caution.)

The researchers identified four hallmarks of what it means to teach mathematics conceptually:

1. **Using mathematical language.** Teachers should use academic language purposefully. That practice helps students develop a technical understanding of the meaning of the words. A past study found that children who were exposed to explicit number names in pre-kindergarten showed a consistently stronger performance in math than their peers for up to six years later.
2. **Using visual representations.** These representations help students make sense of mathematical concepts and understand mathematical structures and the relationships between quantities. Ideally, researchers say

students should be able to flexibly use different representations for the same mathematical concepts.

3. **Pressing students for explanations.** Doing so allows students to further develop their understanding by working through obstacles and contradictions and reaching for connections across strategies. Teachers should establish classroom norms, researchers say, where a good explanation is a mathematical argument and not simply a description of the procedures, and errors are further opportunities to learn.
4. **Using story problems.** Problems with illustrative contexts connected to the real world can help develop students' understanding. When done in a way that challenges students' thinking, the story problems give students a familiar metaphor, they are interesting, and they enhance transfer of learning (see a video explainer of that concept).

During the classroom observations of the six first-year teachers, the researchers found that the teachers were more equipped at teaching math conceptually when they had learned the topic in their preservice classes (which incorporated all four of those instructional practices). When they hadn't been taught a topic in teacher prep, they focused on procedural talk rather than using academic language and conceptual meanings. They also weren't sure of what appropriate visual representations to use to illustrate the concepts.

The teachers were better at using story problems and pressing students for explanations when they hadn't learned the math topic in teacher prep, since both of those skills don't necessarily require a conceptual understanding of the topic at hand. However, in these lessons, the teachers sometimes let students get away from offering more superficial responses, rather than continuing to press.

The researchers noted that the math topics that teachers *had* learned in their preservice program were covered extensively in the first year of the teacher-prep program—and the teachers were still able to retain and draw on that knowledge four years later. This could mean that preservice programs should focus on helping candidates learn fewer topics in greater depth. Indeed, another recent study, also from the University of Delaware, found that the more time teachers spend on a particular math concept in their preservice program, the more likely they are to use that concept in preparing lessons, even six years later. (Both of these studies were supported by the National Science Foundation to improve the math content and teaching methods offered for preservice teachers.)

Still, because the University of Delaware emphasized teaching conceptually, the teachers all indicated in interviews that they wanted to teach students *why* a procedure worked rather than *how* to find the answer. One teacher said: "If you don't have the meaning, [students are] just not gonna care, you know. And when they understand it, they love it."

Another teacher, when asked what she learned in preservice to help her teach math, said: "The language. Thinking of fractions as parts of a whole, equal sized pieces ... I had never thought of fractions like that before. ... All of the foundational things I learned were tremendous in helping me to communicate with [students]. Because then I expect them to use that, too."

But the researchers concluded that fostering a belief in conceptual understanding among preservice teachers is not enough—prospective teachers also need to develop mathematical content knowledge and experience and learn instructional practices. The researchers called for further research on the topic with a larger sample size.

More on Teaching Math: