# 2. Those Who Can, Do; Those Who Understand, Teach

(Originally titled “Uncovering the Math Curriculum”)

In this *Educational Leadership* article, math consultant/author Marilyn Burns explores the difference between covering and uncovering the curriculum. “Learning how to best uncover the curriculum for students has been a long process for me,” she says. “I’ve had to learn when to *ask* and when to *tell*. Even more important, I’ve had to learn *what* to ask and *what* to tell, which calls for thoroughly understanding the mathematical content I’m teaching.”

She remembers how as a young teacher she introduced π as the symbol for pi and its value, taught students the formulas for finding the circumference and area of a circle (C=πd or 2πr and A=πr2), and had them apply the formulas to solve problems – all without students seeing why those formulas made sense. “Being able to compute answers without also understanding the underlying mathematics is an insufficient and shallow goal for students’ mathematical learning,” says Burns. “It builds the erroneous notion for students that learning math is all about learning procedures, rather than making sense of ideas.”

The Common Core math standards are clear about what happens when students don’t get to this level: “Without a flexible base from which to work, they may be less likely to consider analogous problems, represent problems coherently, justify conclusions, apply the mathematics to practical situations, use technology mindfully to work with the mathematics, explain the mathematics accurately to other students, step back for an overview, or deviate from a known procedure to find a shortcut.”

Here’s how Burns would teach circumference now. Given that pi is a constant relationship that exists in the physical world, it’s best to “engage students in a firsthand investigation that can help reveal that relationship to them,” she says:

* Assemble a variety of circular objects – plates, cups, glasses, coasters, jar lids.
* Have students measure the circumference and diameter of one or more of them.
* Ask, “What do you notice?” This focuses students on patterns, structure, and regularity.
* Then ask, “Now, what do you wonder?” which focuses them on making conjectures. “This kind of thinking is fundamental to doing mathematics,” says Burns.
* Students notice (or the teacher points out) that measurement is never exact, and even the best measurements are approximations. But the ratio of the circumference to the diameter is always close to 3.14 or 3 1/7.
* This is where the teacher explicitly explains that we call this pi or π. “No amount of thinking and reasoning alone will reveal this knowledge to students,” says Burns. “This is content that we as teachers need to cover. In such a case, teaching by telling is appropriate and necessary.”

Students’ understanding can be assessed by asking them to measure the diameter of a tree-trunk – without cutting down the tree – perhaps using non-traditional measures.

Burns then suggests a series of questions designed to get students thinking about why we do certain things in math and why they make sense:

• *Why is it okay to add a zero when multiplying whole numbers by 10 but not when multiplying decimals by 10?* Exploring this question helps students understand our decimal system and what zero does to a whole number versus a decimal number.

• *Why is the sum of two odd numbers always even?* Before tackling this question, Burns recommends putting students in pairs and verifying that it’s true, and then having them come up with explanations. Exploring this question gets at the properties of numbers and operations and builds number sense.

• *Why is zero an even number?* There are three “tests” of even-ness, and zero passes all three.

• *Why does canceling zeros produce an equivalent fraction in the fraction 10/20, but not in the fraction 101/201?* Having a class of fourth graders explore this gets at the importance of maintaining proportionality between parts of a fraction as well as decimal number sense.

“Uncovering the Math Curriculum” by Marilyn Burns in *Educational Leadership*, October 2014 (Vol. 72, #2, p. 64-68), <http://bit.ly/1wv1sc7>; Burns is at [mburns1941@gmail.com](mailto:mburns1941@gmail.com).

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