Linking Assessment and Instruction

Making assessment an integral part of instruction is essential for improving the effectiveness of classroom math instruction. When learning math in school, we all experienced doing assignments and taking quizzes to give our teachers information about how we were doing. Typically, these assignments and quizzes called for performing calculations and solving problems with the focus on getting right answers. And while assignments and quizzes are useful vehicles for measuring students' progress, and correct answers are important, merely checking whether or not answers are correct is insufficient. Assessments must also uncover what students understand and provide insights into how they think and reason. Key to assessing students' math learning is to delve into how students arrive at answers.

To accomplish this, assessment must play an integral role in classroom instruction, not only to monitor individual students' progress but also to reflect on our teaching to maximize the effectiveness of our lessons. After teaching a lesson, it's helpful to ask: What did the students learn? If I teach the same grade level next year, should I repeat this lesson? Should I make changes to it? If I decide not to repeat the lesson, how might I rethink what I was trying to accomplish? This continual evaluation of instructional choices is at the heart of both monitoring student progress and improving our teaching practice.

Posing questions is an effective instructional tool for stimulating students' thinking. It is also an essential assessment tool for uncovering what students understand. It's important to consider the kinds of questions, both oral and written, that serve to provide insights into how students think. When we ask a question that calls for a correct response, we need to broaden our listening focus so that we don't listen merely for the correct answer (that we hope to hear) but also push further to listen to the reasoning behind the answer. And while it's typical to probe students when they give an incorrect answer, it's just as important to probe them when their answer is correct. Correct answers can mask confusion.

Here's an example. Fourth graders were asked to write five fractions in order from least to greatest—$\frac{1}{4}$, $\frac{11}{16}$, $\frac{3}{8}$, $\frac{1}{16}$, and $\frac{3}{4}$. They were also asked to write about their reasons for ordering the fractions. After they had time to solve the problem, they participated in a whole-class discussion. Robert reported first. He said with confidence, and correctly, "The smallest fraction is one-sixteenth." When asked to explain how he knew that $\frac{1}{16}$ was the smallest fraction, Robert read from his paper, again with confidence, "Because one-sixteenth is the lowest number in fractions."

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The students had previously cut and labeled strips of construction paper to make fraction kits, and $\frac{1}{16}$ happened to be the smallest piece in their kits (see page 271). The fraction kit—a standard and effective instructional tool—had led Robert to an incorrect generalization. Requiring that Robert give more than the answer, but also the reasoning behind it, unveiled his misconception. This experience called for not only dealing with Robert but also rethinking how to use the fraction kit so that students would understand that we could cut smaller and smaller fraction pieces and find fraction names for even the tiniest sliver.

Incorporating students' reasoning into both written assignments and classroom discussions is a crucial step toward making assessment an integral and ongoing aspect of classroom instruction. It should be a staple of math teaching.

Assessment Through Students' Written Work

One main strategy for assessing students' learning is to incorporate writing into math assignments. There are many ways to present writing assignments that yield information about how students are thinking (see my book *Writing in Math Class* (1995) and also the section "Incorporating Writing into Math Instruction" [page 38]). Here are four strategies.

Ask for more than one strategy. Solving math problems often requires making false starts and searching for new approaches. Students need to develop multiple strategies so that they become flexible in their mathematical thinking and are able to look at mathematical situations from different perspectives. Even when students are performing routine computations, asking them to demonstrate more than one way to arrive at an answer provides insight into their thinking.

Let students set parameters. A good technique for assessing students' understanding as well as differentiating instruction is to make an assignment adjustable in some way, so that it is accessible and appropriate for a wide range of students. For example, asking students to write their own word problems—and solve them—can give you information about their numerical comfort as well as their computational skill.

Assess the same concept or skill in different ways. Students' beginning understanding, although fragile, can provide useful building blocks or connections to more robust learning. Sometimes a familiar context can help a student think about a numerically challenging problem. Using flexible assessment

approaches enables us to build on students' strengths and interests and help them move on from there.

Take occasional class inventories. Compiling an inventory from a set of papers can provide a sense of the class's progress and thus inform decisions about how to differentiate instruction. For example, after students complete an assignment that includes having them explain their reasoning, review their papers and list the strategies they used. Use this information to inform future lessons and for providing intervention for the struggling students.

Assessment Through Classroom Discussion

Incorporating assessment into classroom discussion serves two goals: it provides insights into students' thinking, and it ensures that no student is invisible in the class, that all are participating and working to understand and learn. Try the following strategies. (And for more information about getting the most out of class discussions, see the section "The Importance of Class Discussions," on page 36.)

Ask students to explain their answers, whether or not the answers are correct. Follow up on both correct and incorrect answers by asking students to explain their reasoning. While you know the correct answer, avoid having a preconceived response about how a student should have reasoned. Students can arrive at correct answers in unexpected ways. For example, Brandon, a fifth grader, when comparing $\frac{4}{5}$ and $\frac{3}{4}$, changed the fractions so that they had common numerators—$\frac{12}{15}$ and $\frac{12}{16}$. He knew that sixteenths were smaller than fifteenths, so $\frac{12}{15}$, or $\frac{4}{5}$, had to be larger!

Ask students to share their solution strategies with the class. After a student responds to a question and explains his or her reasoning, ask, "Who has a different way to solve the problem?" or "Who has another way to think about this?" Provide sufficient wait time to encourage students to collect their thoughts. In addition to providing insights into students' thinking and understanding, this method also reinforces the idea that there are different ways to think about problems and lets the students know that you value their individual approaches.

Call on students who don't volunteer. Let your students know that it's important for you to learn about how each of them thinks and, for that reason, to hear from all of them. Reassure them, however, that if you call on them and they don't know the answer, they should just let you know,

because that is valuable information that will help you think about the support they need.

Use small-group work. This technique is especially useful for drawing out students who are reticent about talking in front of the whole class. After posing a problem, say, "Turn and talk with your partner," or "Talk with your group about this." Then eavesdrop, paying especially close attention to the students who don't typically talk in class discussions.

Improving Mathematics Teaching

As stated in NCTM's *Principles and Standards* "To ensure deep, high-quality learning for all students, assessment and instruction must be integrated so that assessment becomes a routine part of the ongoing classroom activity rather than an interruption. Such assessment also provides the information teachers need to make appropriate instructional decisions" (2000, 23).

Making assessment an integral part of daily mathematics instruction is a challenge. It requires planning specific ways to use assignments and discussions to discover what students do and do not understand. It also requires teachers to be prepared to deal with students' responses. Merely spotting when students are incorrect is relatively easy compared with understanding the reasons behind their errors. The latter demands careful attention and a deep knowledge of the mathematics concepts that students are learning.

The benefits are worth the effort. By building and using a wide repertoire of assessment strategies, we can get to know more about our students than we ever thought possible. The insights we gain by making assessment a regular part of instruction enable us to meet the needs of the students who are eager for more challenges and to provide intervention for those who are struggling.