Digging Beneath the Surface: The Power of the Interview

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Assessment Principle: Assessment should support the learning of important mathematics and furnish useful information to both teachers and students.

-Principles and Standards of School Mathematics

(NCTM 2000, p.22)

In this highly charged atmosphere of high-stakes testing, teachers, administrators, and parents should look more closely at what is accepted as evidence of what a student knows and is able to do. Does filling in the bubble next to an answer prove that a child knows or does not know the important mathematics involved in getting the answer? If we, as educators and parents, really want to know what a child knows, maybe we should just ask.

Context for the Exploration

I had spent 24 years in the classroom teaching Grades 3 through 8 when, 6 years ago, I stepped out of the classroom to become my district's mathematics resource teacher. Currently, I am working on an NSF-funded project, Integrating Mathematics and Pedagogy (IMAP), in which video clips that show students' mathematical thinking are shared with preservice teachers (PSTs) to highlight the importance of mathematical content knowledge. As part of our work, we in IMAP wanted to collect video clips of various lessons. I had convinced a colleague, a 15-year veteran, to teach both a traditional and a conceptual fraction lesson on converting between mixed numbers and improper fractions. Her teaching style conflicted with the procedure-driven, traditional lesson, but she graciously agreed to first teach the lesson, as written, from a California State-approved text and then agreed to teach the same concept 4 weeks later, using a lesson more suited to her style: She used manipulatives to develop concepts and structured the lesson to support students in developing their own procedures for converting. We assessed the students' learning immediately after each lesson and again 3 weeks later to gauge retention. On the basis of scores on the two assessments administered after the procedural lesson, we selected students to be interviewed. Selected students were interviewed after the second assessment following each lesson.

Although I had taught in the classroom for 24 years, I had rarely used interview as a way to assess student thinking in mathematics. I had just begun to learn about the fine art of interviewing and was anxious and excited to practice these new skills. The extent to which interviewing would change my ideas about assessment was truly unexpected. I could not have predicted the mismatch between the information I gleaned from the children's paper-and-pencil results and what I learned from talking to them.

Each interview followed a similar format. I asked each child several questions from the paper-and-pencil assessment. For example

Convert 9/5 to a mixed number.

Convert 3 2/3 to an improper fraction.

How many fifths are in 3 wholes?

Compare 7/4 and 1 (whole).

Compare 5/3 and 1 2/3.

As the interviewer, I tried to present a neutral demeanor toward any answer given. I asked the children to explain their thinking about each answer they gave.

Getting Beneath the Surface With Marisa

After the procedural lesson. We were interested in Marisa because she had correctly answered all questions on each assessment. Traditionally, this result would be accepted as evidence that Marisa knew and understood how to convert between mixed numbers and improper fractions.

When I asked Marisa to convert 9/5 to a mixed number, she quickly wrote 1 4/5. She explained, "Well, 5 goes into 9 one time, and there's 4 left over, so I put 4 for the numerator and the denominator stays the same." She said that was how she was taught. Trying another tack, I asked if she could explain to a younger child why she divided the 5 into the 9. Marisa replied, "Because 9 is bigger than 5. So it goes into 9 at least once, to get your answer."

When asked to compare 2 3/8 and 19/8, Marisa read the problem and wrote an equal sign between the two numbers. Marisa offered, "I multiplied 8 to 2 and got 16 and added 3; that's 9, uh, 19." I probed further: "Why do you think you multiplied the 8 times the 2?" Marisa did not know, nor could she explain why she had added the 3.

Her responses showed that despite her facility with algorithms for converting between mixed numbers and improper fractions, Marisa had little understanding of the mathematics of these algorithms. "The assumption that children understand something because they get it right on a test is a fallacy."(Gay and Thomas 1993.) One might question whether Marisa had confidence or experience in explaining her thinking, but in her classroom, students regularly explain and defend their thinking. If only paper-and-pencil tests were considered, Marisa would be deemed "proficient," and, a teacher might presume that she needed no further instruction in this area, a disturbing assumption.

<u>After the conceptual lesson.</u> In her subsequent interview, Marisa articulated a better understanding. She converted 3 3/8 to 27/8 but was silent when asked to explain to a younger child why she had multiplied the 8 times the 3. I prodded her to tell me for what the 8 stood. She answered, "How many pieces there are in a whole. So you would multiply it by the whole number to get how many pieces there are in three wholes." She explained her next step: "Then you add the numerator on too, …because that's the pieces that are like the extra in the whole."

The conceptual lesson was important for Marisa to make sense of the procedure she could use consistently and efficiently. What might have happened to her future success with fractions without that understanding is unclear.

Digging Deeper With Eddie

After the procedural lesson . We chose to interview Eddie because he struggled mightily with the procedural lesson. He attempted only 6 of the 10 assessment items and answered only 2 correctly.

His teacher said

> He had shut down during the first lesson. Numbers are so abstract to him. He's a slow learner, but very bright, but needs to make sense. He's meticulous and needs time to process. Some kids aren't willing to mindlessly follow a rule when they don't make sense of it.

To convert 3 1/8 to an improper fraction, Eddie wrote 3/8 and explained, “The numerator would be three, and that [8] is the same, so it would be the denominator.” I questioned him further about the role of each number. Confusion and frustration played out on his face, and he could not explain what he had done. I asked if I could give him a different problem: “If you had three wholes, how many fifths would there be in three wholes?” Eddie immediately answered 15.

“Wow, that was pretty quick,” I said, “Tell me how you got 15.” He confidently answered that it was 5 times 3. When I asked why he had multiplied 5 times 3, he again responded quickly, “Because there’s three wholes and five in each.”

When working with the algorithm, Eddie had little knowledge about the mathematics he was being asked to recollect. However, when asked a question in a simple context (how many fifths in three wholes?), he could articulate and draw an appropriate answer that illuminated his conceptual understanding. A teacher could build upon this understanding to extend Eddie’s understanding to converting fractions.

After the conceptual lesson. Three weeks later, Eddie’s confidence and understanding had changed dramatically. While he worked, Eddie explained his thinking about changing 3 1/8 to an improper fraction: “First, I would do 3 times 8, and that equals 24. I did that because there’s 3 wholes, and each of them has 8. So there would be 24 eighths. And then plus 1, because there's 1 eighth. That would be 25 over 8" (writes 25/8).

Given the opportunity to make sense of the mathematics underlying the procedure, Eddie demonstrated not only a facility with the procedure but also an elegant explanation of why it works. Yet, given his poor performance on the paper-and-pencil assessment, Eddie would have likely been deemed "nonproficient" or "not meeting standard."

What I Learned First With Randi

After the procedural lesson. A third student, Randi, was chosen as typical of most students because of her assessment scores. She scored well on the assessment immediately following the procedural lesson but did poorly 3 weeks later.

In the first interview, Randi started to change 3 3/8 into an improper fraction, then hesitated, saying," We did this before, but I don't quite remember, because I didn't figure it out for myself." She explained

> Well, when she [the teacher] tells us the answer to something, I try and find out how she got it. So when I figure that out, it is easier. So if I figure it out, it stays there because I was the one that brought it there. It is just easier to do when you figure it out yourself instead of having the teacher tell you how to.

Randi stands out for her unique ability to articulate how she learns. She recognizes the need to construct her own knowledge and the importance of that construction to her retention of the material. I expected that Randi's ability to use the procedure would be enhanced after she had experienced the conceptual lesson. I was wrong.

After the conceptual lesson. During the subsequent interview, when again asked to convert 3 3/8, Randi began by saying, "The way that I was taught was times 3 (writes 3 x 3/8), which would be 9 (writes 9), plus 8 (writes + 8) equals 17 (writes 17). So it would be seventeen-eighths (writes 17/8). Or really, you could just do. . . ."

At this point, Randi drew a circle and divided it into eighths. She drew two more circles and indicated there would be 8 more eighths in each. Then she drew 3/8 of a circle [see Figure 1]. To explain, she said, " It has to be 3 times 3, because there's three wholes. So it has to be 3 right here [points to first circle divided into eighths], three right here [points to second circle]--or eight right here (points to first circle), eight right here (points to second circle), and eight right here [points to third circle]. Let me try this again. There's. . . ."

Randi now appeared truly troubled. Her drawing clearly did not match the procedure she had followed, and her disequilibrium was evident. In an effort to scaffold what she did understand, I pointed to each circle and asked how many pieces were in each. She correctly counted "eight, eight, eight, and three left over." She quickly calculated the total as 27/8.

I asked her which answer she thought was correct (17/8 or 27/8). She pointed to the circles and said 27/8. I pointed back to the 3 3/8 and asked if there was any way to justify her new answer. She thought for a few seconds and replied, "I could multiply this (writes × between 3 and 8) and then add the numerator (points to *3* in 3/8). I asked if doing so would make sense.

"Yeah," she replied, "because eight is one whole, and there's three wholes. So there has to be 8 times 3, which is 24. And then you would have to add the remainders."

However, now I was confused. Why would someone who could make sense of the problem and solve it correctly using her own strategies choose to use a procedure she could neither remember nor use effectively? So, I asked, "Randi, I am still kind of a little bit curious: When I showed you this, this time, you still wanted to go to the rule, even though you didn't quite remember it the right way. Why do you think you do that?"

"Well, because I was taught that [procedure] first, she replied, " . . . I went to that because I just remembered that. And I was taught that before, so then once I tried to figure it out, it didn't work. "

Gardner (1991) stated in *The Unschooled Mind* that learners sometime revert to prior knowledge despite having been taught the "truth." So even when Randi knows and understands a strategy for converting fractions, she reverts to a process she was taught first. A topic hotly debated during various discussions with our preservice teachers and in my work with in-service teachers and methods students is the issue of whether the order in which one teaches concepts or procedures makes a difference. Randi's struggle might help inform our instruction.

Just Because It Looks Right With Melanie

The last child, Melanie, I describe only as a cautionary note. A child may get the right answer for the wrong reason. I asked Melanie to compare 5/3 and 1 2/3. She put an equal sign between the numbers and explained, "I think they are equal because 5 times 3 is 15 and I thought maybe that [2/3] is five and that is 1 [in 1 2/3]. Melanie had multiplied the 5 and the 3 to get 15 and then added the 2 and the 3 from the 2/3 to get 5, which when placed next to the 1, made a whole number that looked like 15 [see Figure 2].

As teachers, we ask children many questions, but we rarely question them further when they give the right answer, believing, I suppose, that if a child gets the right answer, the child must understand what he or she is doing. Again, on a paper/pencil test, Melanie's response would have been correct and no one would be the wiser.

Filling the Holes

As we had anticipated, the students scored better on the paper-and-pencil assessments given 3 weeks after the conceptual lesson, than those given 3 weeks after the procedural lesson. That is another story for another time.

This story is about the power of the interview as a way of assessing what a student knows and is able to do in an authentic, perhaps the most authentic, way. When interviewed, a child can neither hide behind an algorithm he or she does not understand nor rely on a lucky guess or test-taking tricks. The value of interviewing goes beyond what we learn about individual children. Interviews also provide accurate information that can be used to inform instruction. Would you help students like Melanie in the same way as Eddie? Would we have accurately represented what these children knew and were able to do without their explanations?

Vygotsky (1962, 16) said, "Speech is an expression of becoming aware." In many of the examples cited, one can hear the students becoming aware of how conceptual ideas of fractions are interwoven with the procedures derived from those ideas. In responding to questions about their thinking, students shape and modify their thoughts and self-correct.

Interviewing does take time, but it need not be formal or time-consuming. Creating a classroom environment in which students are expected to explain their thinking and justify their answers is a good start. Consider building a cache of key interview questions about concepts within the curriculum you teach. These questions could be asked at appropriate times during the year as a form of assessment. For more ideas about questioning and discourse, see the article *Questioning Your Way to the Standards* (Mewborn and Huberty, 1999.*)*

Of course, interviewing is not for the faint of heart. During a collaborative meeting focused on interviewing, one teacher lamented, " I got very frustrated when the student couldn't explain things I thought he understood." What frustrates me the most is not having used interviewing in my own classroom to assess student understanding for 24 years. As stated in *Assessing for Learning* (Labinowicz, 1987)

> Such provocative findings—currently masked by an overdependence on paper-and–pencil evidence of learning—are likely to challenge your classroom practice. What you learn from children in a few interviews can have a dramatic effect on what you teach, when you teach it, how you teach, and how you evaluate children's progress. (p. 22)

In spite of my frustration, I am inspired by knowing that it is never too late to implement this powerful tool and to share its power with others. Learning what your students really know takes courage and getting your hands dirty, but uncovering this information is well worth the dig.

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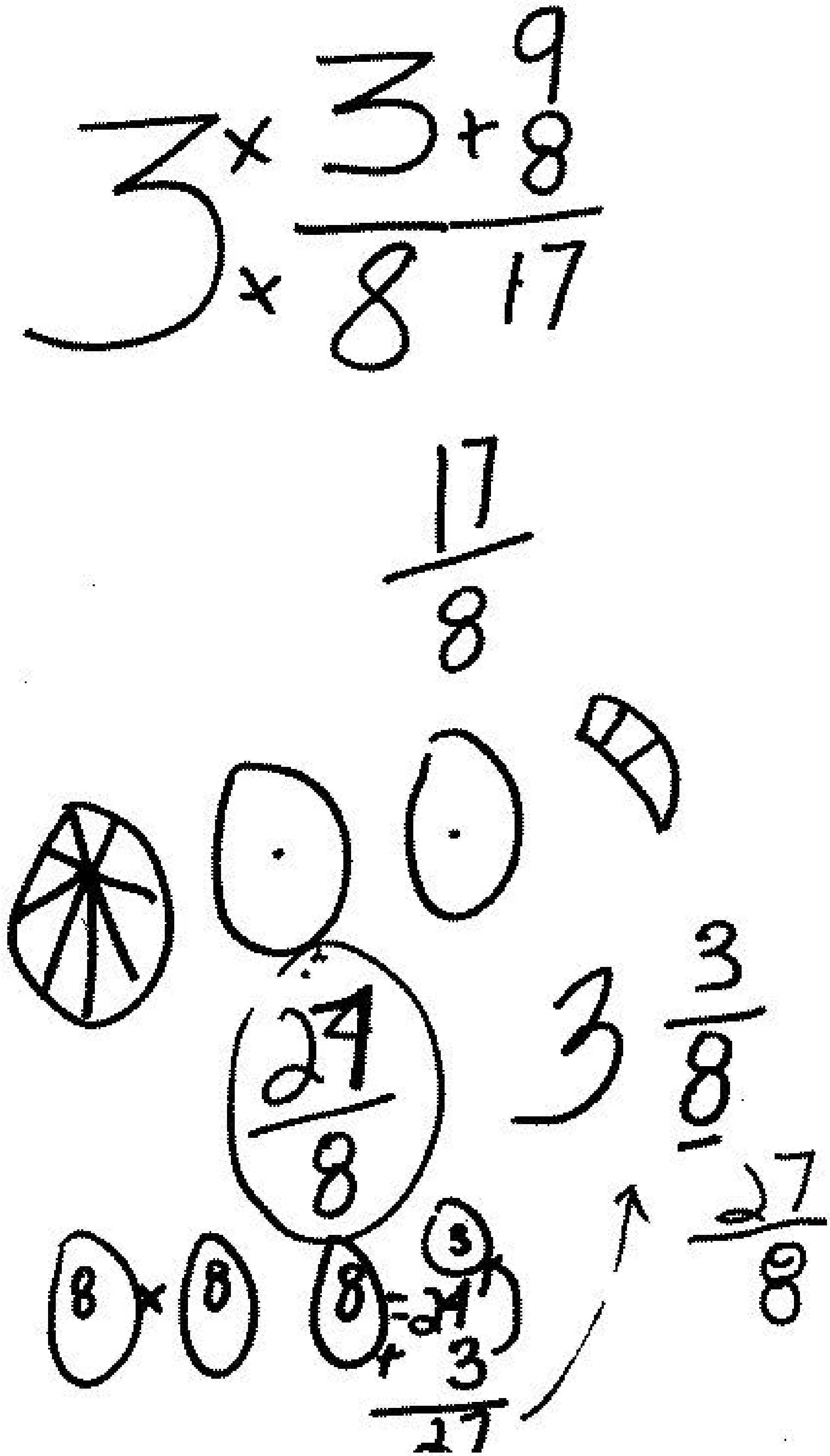
Figure Captions

Figure 1 – Randi’s work during the second interview.

Figure 2 – Melanie compares 5/3 and 1 2/3.


3 × 3 + 9
× 8 17
17/8
27/8
3 3/8
27/8
8 × 8 8 = 24
+ 3
27