Tricia Murphy

Changing Assessment Practices in an Algebra Class, or "Will This Be on the Test?"

After several years of teaching high school mathematics, I was pleased to be asked to teach college algebra at our high school as part of a program designed to prepare students to "test out" of college algebra at area colleges and universities. I had taught this course at our local university, and I looked forward to teaching it again.

When I received the syllabus, textbook, and sample examinations, my feelings were mixed. My approach to teaching mathematics had shifted since I last taught the course. I now realized that this course in its traditional form was a filter: rote skills, symbol manipulation, little or no application—preparation for doing well in the "next class." I had a responsibility to prepare these students for the reality of college mathematics. Skills and symbol manipulation are important, but I wanted to convey the bigger picture of mathematics and to increase the odds that this course would not be the last mathematics class that the students took. For many degree programs at many universities, college algebra is the only mathematics course required.

Included in NCTM's vision is a shift in learning mathematics toward investigating, formulating, representing, reasoning, and applying a variety of strategies to the solution of problems. Emphasis has shifted from memorizing and repeating (NCTM 1995, 2), resulting in a flood of activities and real-world problems at conferences, in journals, at workshops, and in the new textbooks. I had been slowly but eagerly changing the way in which I taught mathematics. I was asking my students to figure things out on their own, to make connections, and to make sense of the mathematics that they were learning. We used a variety of mathematical models, and students discovered relationships and developed formulas. As a result, my classroom had become much more interesting for me and for my students.

My goal for college algebra was to find a way to incorporate the kinds of instruction that I knew worked best without presenting what might seem to some university faculty to be a watered-down curriculum lacking necessary algebra skills. I began working on a balanced approach to addressing the need for problem solving and for basic skills. I discovered that the two are not mutually exclusive.

During all this investigating, formulating, and representing, students frequently asked me, "Will this be on the test?" and I frequently gave an evasive answer—avoiding "just saying no."

I experimented with investigations; I asked students to generalize after they identified the pattern; I asked them to supply the rules rather than rely on me. They objected strenuously. But I carefully monitored skill development by testing almost exclusively on rules and procedures.

The sixth NCTM assessment standard is the Coherence Standard, which states, "Assessment should be a coherent process" (NCTM 1995, 21). Essentially, this standard means that the assessment should be aligned with the curriculum and with instruction. A coherent assessment system cannot be based on a single method of assessment. Instead, a balance among appropriate and varied assessment methods can help all students learn and help the teacher make instructional decisions. When I looked at my assessment system, I realized that my instruction was not aligned with my assessment. No wonder that I was frustrated when the students would not think or investigate. They wanted to know only what would be included on the test. They were waiting for me to wrap it up and show them how to "do it." After all, that was what

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would be on the test—twenty problems where they would have to "do it."

Look at the most recent test that you gave to your class. How many questions asked students to investigate? Were students asked to formulate? Did they need to apply a variety of strategies? How many questions asked students to repeat memorized algorithms to solve isolated problems? I realized that although my instruction had shifted toward NCTM's vision, my assessment practices had not.

What we assess communicates what we value. If I valued investigating and problem solving yet gave a test that asked for procedures and algorithms, what message was I sending to my students? Tests counted for 75 percent of their grade. I was communicating to my students that I valued regurgitation of the processes that I had demonstrated in class.

What we assess communicates what we value

My first attempt to change my assessment was on a quiz that I gave my students in 1995. The students were not pleased and told me they did not like having to think. They said that it was easier when they just had to know how to do a problem, not answer *why* or *what if*. The following is a sample of questions from that first quiz:

1. A student claims that the equation $\sqrt{-x} = 3$ has no solution, since the square root of a negative number does not exist. Why is this argument wrong? Give examples to support your answer.
2. Without using a calculator, arrange the following from least to greatest. Explain your reasoning.

$$\left(\frac{4}{25}\right)^{\frac{-1}{3}}, \left(\frac{25}{4}\right)^{\frac{1}{3}}, \left(\frac{4}{25}\right)^{\frac{-1}{4}}$$

3. Explain why in exponential expressions involving half-life, the exponent is usually the number of years divided by the half-life; and in expressions involving compound interest, the exponent is the number of years times the compounding period.

The students were not really prepared for these kinds of questions. Yet I had asked them these kinds of questions in class many times. They had experimented with rational exponents and discussed their meaning. However, my students had been conditioned to think that these kinds of questions do not really matter because eventually what is going to be on the all-important test is just a bunch of problems. I had a lot of work to do. Fortunately, I have been able to teach this subject for the last three years. Each semester I change a little bit more.

Changing assessment does take time. That concern is valid. But assessments do not have to intrude into instructional time; they should be opportunities for learning. I have begun to replace my traditional assessments rather than add alternative assessments. I still give unit tests and assessments that I think will prepare my students for traditional tests, but I am changing the types of questions that I put on the tests. I still assess the students on algorithms and symbol manipulation. They need to have these skills, but they also need more. Each of the following counts for approximately one-third of a student's grade.

Quizzes

The frequent, short, in-class quizzes with one or two problems assess the students' understanding of basic skills and procedures. I can quickly tell who is totally lost and who is keeping up. I grade quizzes on a four-point holistic scale:

4 points = I know that you know it.
3 points = I think that you know it.
2 points = I do not think that you know it.
1 point = I know that you do not know it.

Sample quiz question. The half-life of a radioactive element called strontium is 19.9 years. If initially there are 35 grams of strontium, how much radioactivity will remain after 50 years?

Writings

At least every two weeks I give the students an assignment that involves investigating, formulating, and explaining their thinking. We may do part of the investigation as a class, or it may be done outside of class. Students' writings are also graded on the four-point holistic scale.

Sample writing. Mrs. Murphy made up a wonderful worksheet of problems that can be solved using exponential equations. Somehow it got lost on the way to the copy machine. All that remains is this partial answer key with the equations set up. Your task is to write questions that would fit the given equations.

1. $y = 100(1.07)^x$
2. $y = 2500\left(1 + \frac{.04}{4}\right)^{60}$
3. $y = 30(0.5)^{\frac{400}{150}}$
4. $5000 = p\left(1 + \frac{0.10}{2}\right)^{14}$
5. $200 = 100\left(1 + \frac{r}{12}\right)^{120}$
6. $36{,}000 = 57{,}000(.83)^x$

Sample writing. The following is a list of times for winners of the 100-meter dash in the Olympics for the last seventy years. Find a mathematical model for the data. Explain why you think that your model is a good one. Show all work involved, including graphs and calculations.

Tests

I am trying to move away from reassessing everything that I have assessed during the previous weeks. A test should focus on assessing what students know rather than point out what they do not know. For the students' comfort and to prepare them for future high-stakes tests, I do use four or five objective, usually multiple-choice, questions that are similar to the short quiz questions. I try to include a few questions that ask the students to explain whether a given statement is always true, never true, or depends on the value of the variables. Then I aim for two or three questions that involve synthesizing and applying their knowledge. These questions no longer shock the students. We have been doing them in class. They have been writing and explaining mathematics throughout the unit. I also give them such choices as picking two of three questions or omitting one question from the test.

Sample question. The following is an excerpt from the February 1997 issue of the Hickman *Guidance Department Newsletter.* Verify the four-year-college costs stated in the article. Explain any discrepancies between your answers and those in the article. Show all calculations. Calculate the cost for you to attend college for four years.

According to the College Board's annual tuition survey, the average cost of attending a four-year public institution is $6823, for tuition, room, and board. This does not include books, transportation, supplies, clothing, or entertainment. The average cost of attending a four-year private college is now $17,631 a year. If rates continue to increase by 6% a year, you can expect four-year costs to reach about $80,150 and $207,112 respectively, by 2014, when your newborn will be ready to go.

Sample question. Which salary is a better deal, a starting salary of $18,000 with 6 percent raises each year or a starting salary of $24,000 with annual raises of 3 percent? Justify your answer. Write two conclusions that you can make from your results.

I would like to be able to say that my students never ask, "Will this be on the test?" I still hear that question in my classroom. However, every year my students see more clearly that everything we do in class is relevant to their lives and to the assessment process, and at least now I can answer "yes" more frequently.

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