Ongoing Student Assessment: Approaches in Mathematics

SUMMARY

The importance of continuous assessment using varied methods is described by this middle school mathematics teacher. She advocates for a flexible approach — particularly for students with unique needs.

As a middle-level mathematics teacher with more than 50 years of experience, including serving as department chairperson for mathematics and computer instruction, I have seen tremendous change in assessing the results of our teaching. During the early years of my career, frequent quizzes supported by unit tests were the primary tools for assessing students. Today, teachers use a range of classroom assessment strategies to inform and critique their teaching and respond to student needs. Examples of such assessments include projects (Yetkiner, Anderoglu, & Capraro, 2008), journals (Burns & Silbey, 2011), both oral and written exams, and "do now" questions upon entering a classroom. My approach is to use multiple tools in a continuous and flexible process. I have found that this approach improves learning outcomes, especially when working with students who have disabilities or other students who have difficulty mastering mathematical concepts.

Establishing a Safe Environment for Learning

My first priority at the beginning of the school year is to administer and analyze the results of a mathematics pre-test. My next priority is to create an encouraging and supportive learning environment for my students (Dorman, 2002). With students who have difficulty with mathematics, I seek to enhance student engagement with the content. At the outset of the school year, the "I hate mathematics" student may immediately say "I don't know" when asked a question. Therefore, over the years I have learned to start off the school year by addressing the entire class for a choral response: ***"Class, what is the answer?"*** This simple approach reduces apprehension for the majority of the students. The students begin to

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feel comfortable speaking aloud in class. Once students actively engage in class discussions, I can successfully assess their progress through more direct questions to individuals.

Other ways to create a safe environment for students are providing them with behavioral guidelines and maintaining positive interactions. Taking a cue from a television quiz show, I sometimes ask a struggling student if he or she would like to "phone a friend" to receive some assistance or have a peer act as a "lifeline."

Examples of Ongoing Formative Assessment

On a daily basis, I incorporate ongoing flexible formative assessments into my teaching:

> Formative assessments are used to guide instruction. Formative (classroom-based) assessments occur during teaching and are embedded in instruction. Results are received instantly, which allows teachers to adjust their instruction immediately. These are typically teacher developed and should be implemented based on teacher judgment. (American Federation of Teachers, 2008, p. 3)

The following examples will illustrate how ongoing flexible formative assessment can be incorporated into mathematics instruction.

Polynomials

A polynomial is an algebraic expression that is made up of one term or the sum or difference of two or more terms consisting of the product of numbers and/or variables. Adding polynomials is a skill drawn from the *NYS Mathematics Core Curriculum* Standard 8.A (8.A.5: Use physical models to perform operations with polynomials; 8.A.7: Add and subtract polynomials). In the *NYS P-12 Common Core Learning Standards for Mathematics*, this is represented in High School Algebra (A-APR1).

I use **Warm Up problems** to assess students' knowledge of the key concepts which are foundations to this

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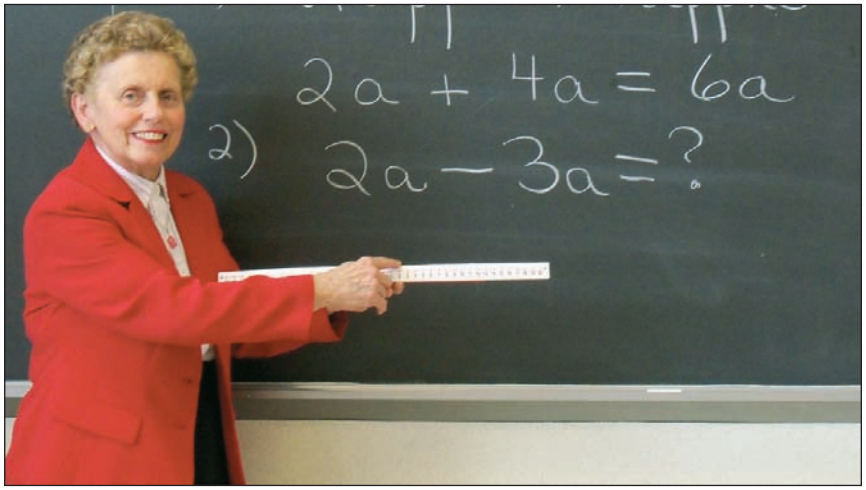
Adding Polynomials

Add:

$$\begin{array}{r} 5s + 6t - 2v \\ 7s - 2t + 3v \\ \hline \end{array}$$



Martha Strever uses a number line to assist students in reviewing math concepts.

particular skill. I have introduced the concept of "like" and "unlike" terms to the students during the previous day's lesson. The Warm Up problems draw on that lesson and require students to successfully classify specific terms as "like" or "unlike."

"Like" terms would be the ***same*** variable raised to the ***same*** power. For example, $2x^2$ and $3x^2$ are like terms.

"Unlike" terms have ***different*** variables or the ***same variable with different exponents***.

At times, using associations can make the concept more concrete. For example, I might tell students:

"Let's look at **like** terms."

"4*b* and 5*b* are **like** terms."

"Imagine that *b* stands for bananas."

Pointing to 4*b*: "The variable in ***this*** term is **b**ananas."

Pointing to 5*b*: "The variable in ***this*** term is **b**ananas."

"It's **all** about bananas! 4*b* and 5*b* are **like** terms."

"Let's look at **unlike** terms."

"4*b* and 5*g* are **unlike** terms."

"Imagine that *g* stands for grapes."

Pointing to 4*b*: "The variable in ***this*** term is **b**ananas."

Pointing to 5*g*: "The variable in ***this*** term is **g**rapes."

"Bananas and grapes. Not the same! Not alike. So… 4*b* and 5*g* are **unlike** terms."

I walk around the room to observe/assess students' work on their Warm Up problems to determine who has mastered this foundation concept. Students struggling with the Warm Up problems receive individual attention. This formative assessment information directly informs what I do next, such as giving more problems or altering my assignment. As we move on to adding polynomials, each student is asked to create and solve her or his *own* problem, which can be presented at the end of class. This allows me to quickly assess students' understanding of the particular skill/concept.

Polyhedrons

Projects can be an effective method of assessment. To assess students' knowledge regarding a component of curriculum related to measurement, angles, and constructions, I use a project entitled "polyhedron creations."

A polyhedron is a three-dimensional geometric solid with flat faces and straight edges.

I begin with the tetrahedron, composed of four triangular faces, three of which meet at each vertex. Student are provided with a lab sheet similar to a handout they might receive in a science lab. This includes:

- the objective,
- a list of required materials, and
- the process for arriving at the end result.

I start out by assessing students' use of the ruler and protractor. After any needed instruction, students apply this knowledge to draw angles of predetermined measures. Once the design is completed, the students fold and glue the figure together. Upon completion, the students:

- analyze their own creation by viewing a sample,
- evaluate and critique each other's design for accuracy — through peer review, and
- create a more difficult model with less support.

They are evaluated according to:

- angle accuracy,
- line measurement accuracy,
- neatness, and
- following instructions correctly.

Additional Assessment Techniques

Quick Quiz

Once or twice a week students are given a "quick quiz" to check for understanding. I allocate 5 to 10 minutes, during which time I am walking up and down the aisles analyzing student work. At the conclusion of the quiz, I can initiate alternative approaches because my observations have immediately informed my actions.

Math Notebooks

Student notebooks can also be used as a means to assess student learning. At the outset of the semester, I work with the students to establish an organizational structure in their notebooks, so their accumulated notes may serve as a learning log of the semester's activities. In addition to helping assess student mastery, learning logs are also a useful literacy strategy (Friedland, McMillen & del Prado Hill, 2010-11). Students' notes are reviewed to determine whether they have accurately captured the

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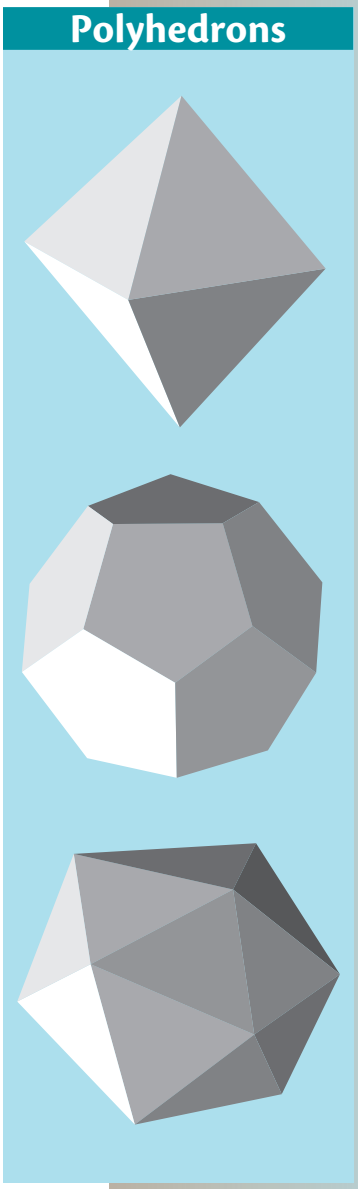

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class objectives and key concepts. I assess based upon organization, neatness and completeness. The completeness not only means copying notes from the blackboard but also showing all steps in solving problems.

Segmenting Unit Exams

Over time I have developed a unique approach to designing unit exams for students who struggle with mathematics. In classes with students with disabilities who have the accommodation of extended time, but do not require a separate setting, a unit exam that is segmented (i.e., broken into sections over the course of a week) is helpful. (This practice appears to work better for all students.) Students still receive their accommodation, but due to this design, often finish with peers. I design the tests/quizzes so every concept will be assessed in the initial 10 questions. I can analyze each of those problems to see if sufficient understanding has occurred or whether more support or reteaching is required. This practice appears to lead to better outcomes. Some students find mathematics overwhelming. Long assessments often frustrate and discourage students, which can lead to poor performance. A carefully designed brief assessment can often provide the information the teacher needs.

Homework as an Assessment Tool

Teachers have varied opinions about assessing their students through homework assignments. I find lengthy homework assignments quite unreliable and not helpful for students who are struggling. If a teacher assigns 20 problems related to a particular skill and the student has not mastered the skill or concept, he or she may be repeating the same mistake 20 times. A homework assignment of this nature reinforces an incorrect technique. Once an incorrect technique is learned, it is very difficult to unlearn (Sousa, 2006, p. 99). An alternative is to ask students to demonstrate their understanding through three or four problems.

Changing Attitudes and Building Skills

Assessment should enable an educator to be more effective with each individual student. This requires frequent use of various tools, well beyond the standard test or quiz format. Good assessment practices lead to more effective teaching and increased student learning. It is particularly rewarding when a student who struggles with mathematics recognizes the joy and satisfaction of mastering a new and difficult concept. I want my teaching and assessment approaches to contribute to that outcome. I want to hear my students say, “Math is fun and I love it!”

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Additional Resources

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