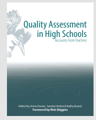

CHAPTER 9

Mathematics Teachers are Ahead of the Curve When It Comes to Assessment *for* Learning

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As the phrase 'assessment *for* learning' is used more and more, some mathematics teachers find themselves wondering how their practice conforms to its precepts. They wonder whether they are behind the times. In some people's minds, assessment *for* learning seems to be better suited to the Humanities or perhaps even the sciences, but it doesn't fit well with mathematics. I think mathematics teachers are in a great position with regard to assessment *for* student learning. I am confident that math teachers have many teaching practices that follow assessment *for* learning recommendations and lead to student improvement. And yet, we, like all teachers, are challenged to continue to learn and change. This chapter proposes that math teachers have been leaders, in some cases without knowing it, in the use of assessment *for* learning.

Research-Based Practices

Assessment *for* learning (AFL) involves using assessment in the classroom to increase learning and raise pupils' achievement. AFL is based on the idea that students will improve most if they understand the goals of their learning, where they are in relation to those goals, and how they can close the gap between where they are and where they need to be. This approach to education is based on decades of research from many sources. The results of this research are not in dispute.

Assessment *for* learning is a research-based theory of learning and teaching which has many components, all of which have been shown to improve student learning. Key ideas include:

- Providing clear learning targets,
- Using samples and exemplars of student work to help students understand quality, and,
- Providing continuous, high-quality feedback from a variety of sources.

The recommendations regarding assessment *for* learning based on the research also emphasize the importance of multiple opportunities for students to revise their work based on the feedback they receive, as well as the provision for students to provide alternative proof of what they have learned.

"...math teachers have been leaders, in some cases without knowing it, in the use of assessment ***for*** *learning."*

It is anticipated that teachers using AFL will engage in formative assessment; that is, they will use the information gathered from student assessment to alter their teaching based on the student strengths and address needs identified from the assessment process. The 'assessment' part of assessment *for* learning refers to the gathering of information regarding student understanding, knowledge of application, and articulation of mathematical ideas. Teachers then use that information to support both student learning and teacher practice. Evaluation comes after assessment *for* learning and is most accurate when it is based on most recent, most consistent evidence of learning rather than grades of all assessments taken during the school year. This is a key point for many mathematics teachers. Rather than averaging or using some other mathematical formula to determine the final grade, teachers look at the evidence of learning collected and determine whether or not it is useful in providing an accurate account of what has been learned in relation to the course outcomes.

Transforming Current Practices

Assessment can be formal or informal. Formal assessments include tests, writing samples, or student projects. Less formal sources of assessment information include observations of a student working, conversations regarding the current assignment, or a one-question quiz at the end of the class to check students' understanding of the day's work. There are many practices in mathematics classes that illustrate assessment *for* learning in action. For example:

1. Assignments with an available answer key allow students to self-assess their knowledge to obtain continuous feedback.

2. When teachers of mathematics walk around checking work and talking with students they are providing feedback, as well as gathering and regarding student understanding of mathematical concepts.
3. Handing back a piece of student work with corrections and written ideas for improvements can also offer students high-quality feedback.

These types of assessment *for* learning have been done for years in mathematics classes; however, it is important to take these actions with explicit intent and to ensure that students understand why we are doing these things.

Students must be aware of the reasons for having this feedback and of how to use this feedback to help their learning. Those students we would traditionally consider good students are often able to do this on their own without much prompting by the teacher. Struggling students are often unable to translate teacher feedback into better performance.

"Homework is... practice and should not be graded."

Like many teachers, I give regular quizzes in my class. One change I made in my practice is to make explicit to students that the point of the quizzes is to have the students check to see what they know and what they don't know regarding an area of study. To increase the likelihood that this is the only message students are given regarding quizzes, I offer no grades for the quizzes. I explain to students why I don't grade practice. The only change I needed to make to conform to AFL was to remove the grades on quizzes and other practice work.

Homework is practice. The point of doing homework is to gain automaticity with the material and to identify problems in students' understanding of material. It is still practice and should not be graded. I justify this by asking how often I was grading, based on a practice drive as I learned to handle a car or if I was judged as I refined my skills on the volleyball court. Once students understand the reasons for the assigned practice and see that it works, they do it without complaint. Those who don't do it will learn of its value through trial and error. I still check homework so I can identify problems with students' understanding, but that checking reinforces the message I want to send regarding homework. If a student chooses to not do homework and yet needs to have that practice, I talk with them and provide closer supervision. Students come to understand that homework is useful in our goal of understanding math better, rather than something to gather grades (or to punish or reward them). It helps students see me as someone who is there to support their learning.

Being clear with students about what they need to learn, I give them a list of standards for each unit. Then, I have students go through it with me, thinking about their own work. They are expected to write about what they do well, what they struggle with, and why they believe that is the case. This process supports student understanding of where they are with respect to math standards as well as meeting some of the requirements regarding communicating mathematically. The process is collaborative, student centered, and by my students' own admission, useful. This account of their learning is saved and used later as students reflect on and collect evidence of their learning in relation to the mathematics standards.

Math teachers have always tried to be responsive to student needs. When we look at the results of a mid-unit quiz, or know, through teacher-student interaction, that a large portion of the class may not understand a concept, then we spend more time with it and re-teach concepts. We spend individual time with certain students who we see, through informal assessment, may need extra help to understand a concept. Math teachers already explain a concept in many different ways using visual aids, manipulatives, and real world examples. When a student asks a math teacher for help, that is a self-assessment. Our response is collaboration with the student to help them understand the mathematical concept with which they are struggling. The change? We now explain to students what mathematics teachers do to support their learning, how we think it helps, and invite students to identify other things we could do to support their learning.

"By being explicit about my expectations, students better understood the purpose of each task and activity."

Only recently I've begun writing clearly on the board what I hope the students will understand, be able to do and be able to articulate by the end of class. An example would be: "Today you will be able to find the reference angle for any given angle, and you will find the exact value of a trig function using reference angles." This allows students to know exactly what is expected of them from the beginning of the class. I was surprised that many of my students did not know what I wanted them to know at the end of the class. By being explicit about my expectations, students better understood the purpose of each task and activity. Making explicit all of the learning targets for each class and keeping to that learning target has been a powerful change, although there are still times when I want my students to get to the targets on their own. In this case, I will use the learning targets at the end of class rather than the beginning.

A final area of change involves evidence of learning, which can take many forms. The traditional form for math teachers is the unit test and comprehensive final. They offer students a chance to show what they know by working a set of problems in a set amount of time. Alternatives do exist. Some examples: Students can write regarding their understanding of various mathematical techniques – explaining how and why specific techniques work, with a discussion of their strengths and weaknesses. Students can also devise or strengthen existing questions, with an accompanying explanation of why the work done reflects an understanding of concepts. They can work through real-world questions, either alone or in a group, grappling with the messy nature of problems that are not 'cooked' for the classroom. Although they are considered time consuming, student interviews don't have to be awkward and can give a very good picture of what students understand. They can be short and focus on a single concept. For example, I like to talk to my students individually regarding the expansion of a squared binomial like $(x - 3)^2$. The reason for this is that many students choose to use their own rule to 'distribute the square' and end up with either $(x - 3)^2 = x^2 - 9$ or $(x - 3)^2 = x^2 + 9$. I might follow up on their answers by asking them about the statement $(5 - 3)^2 = 5^2 - 3^2 = 16$ as a parallel example or ask them to compare the factored form of $x^2 - 9$ to $(x - 3)^2$ and explain where they see differences. If they answer my initial question with $(x - 3)^2 = x^2 - 6x + 9$, I might ask why it isn't $x^2 + 9$ or ask them to explain their work in English rather than the language of mathematics. By tailoring the follow-up questions to allow students to explain their thinking and struggle with inconsistencies, I get a better insight into their thoughts and the students get a chance to re-arrange their own understanding of math concepts. Math teachers have done this, both at the board in larger groups and with individuals, for years and years. The difference is that I am explicitly working to assess the misconception of the students, whatever that might be, and then engage students so that they rearrange their concepts. I can convert this into short notes to follow up on and be more confident in my insights into the quality of the understanding held by my students.

By opening the door to alternative ways of showing understanding, we as teachers can also invite our own students to devise acceptable ways of demonstrating proof of learning that we may not have thought of ourselves. By rearranging our work, we can spend more time assessing our students and responding to the understanding they show, and less time defining the form student understanding must take.

This chapter examines what I believe to be the practice of many mathematics teachers and compares that practice to the precepts of assessment *for* learning. While we still have some challenges to address, we mathematics teachers have less to apologize for than some people would suppose.