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Descriptive Study

In 2011, Mid-continent Research for Education and Learning (now McREL International) was awarded an Institute of Education Sciences grant to develop and study a program aimed at building middle school mathematics teachers' knowledge and skills for implementing high-quality formative assessment. The foundation for the professional development program, Learning to Use Formative Assessment in Mathematics with the Assessment Work Sample Method (AWSM), was built on authentic samples of student work, because reviewing and discussing student work helps teachers shift from thinking of teaching as something teachers do to a focus on learning as something students do (e.g., Hattie, 2009). Through our evaluation of the program's impact, we learned that the formative assessment practices supported by AWSM improved the class culture and encouraged students to take more ownership of learning, and during this process, connections between personalized learning and the formative assessment process advocated by AWSM began to materialize. In this chapter, the comprehensive definition of personalized learning described in *Through the Student's Eyes: A Perspective on Personalized Learning* (Redding, 2013) most clearly reflects the focus group statements voiced by teachers in the study. Thus the description, "personalization ensues from the relationships among teachers and learners and the teacher's orchestration of multiple means for enhancing every aspect of each student's learning and development" (Redding, 2013, p. 6) is used. This chapter discusses the challenges to mathematics teaching and learning, the AWSM professional development program, focus group feedback, and how the formative assessment process connects to personalized learning.

Challenges to Middle School Mathematics Learning

In the transition to middle school and during the middle school years, students' motivation for mathematics tends to decline from what it was during elementary school. At this age, students report less valuing of mathematics and lower effort and persistence in math problem solving than reported by students in earlier grades (Pajares & Graham, 1999; Valas, 2001; Wigfield, Eccles, & Pintrich, 1996). Middle school students also report lower

confidence in their mathematics ability than before (Clarke, Roche, Cheeseman, & van der Schans, 2014; Pintrich & Schunk, 1996), influenced in part by exposure to a larger peer group with whom they begin to compare themselves. They also perceive more competition in the classroom environment and more rigorous standards for evaluation (Eccles & Midgley, 1989).

A review of national assessment results provides another perspective on mathematics learning. Mathematics results on the National Assessment of Educational Progress (NAEP) in both Grades 4 and 8 have shown significant progress since 1990, particularly for Grade 4 students. From 2000 to 2013, Grade 4 proficiency levels increased 18 percentage points, while Grade 8 proficiency levels in mathematics increased 10 points. In spite of these improvements, in 2013, NAEP results showed only 42% of Grade 4 students proficient in mathematics, with Grade 8 proficiency levels at 35%. This difference between the two grades' rates of mathematics proficiency contrasts to a near parity in proficiency levels in reading for Grade 4 and Grade 8, 35% and 36%, respectively (The Nation's Report Card, 2013).

The tendency to oversimplify tasks is especially true when teachers work with lower achieving students (Zohar, Degani, & Vaaknin, 2001).

How students perceive themselves as mathematics learners can have an effect on teaching and learning at the middle school level. Students who are not confident that they can solve complex problems or who do not see the point of putting forth effort to do so try to avoid those tasks or pressure teachers to make the work simpler for them (Clarke et al., 2014). This lack of self-efficacy is a predictor of, among other things, lower math achievement outcomes (Pajares & Graham, 1999), and some middle schoolers attempt to engage in math learning only when tangible rewards are offered (Rowan-Kenyon, Swan, & Creager, 2012).

In this environment, middle school mathematics teachers can feel discouraged from giving students challenging and complex work. If they do so anyway and students encounter difficulty, some teachers oversimplify the task or tell students how to solve it (Clarke et al., 2014; Ferguson, 2009). The tendency to oversimplify tasks is especially true when teachers work with lower achieving students (Zohar, Degani, & Vaaknin, 2001). However, the common core state standards and other contemporary U.S. math standards require that students be able to solve complex problems and to explain their reasoning, so teachers need strategies to support students in these practices.

Formative Assessment Strategies

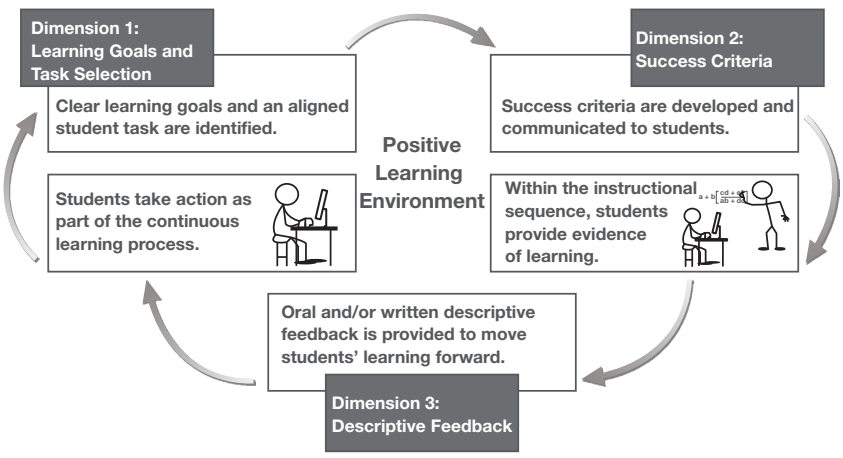
Formative assessment strategies can help students be more confident learners and can positively impact academic performance (Peterson & Siadat, 2009; Ruland, 2011; Wilson, 2009). Formative assessment is an evidence-based process of gathering information on three questions—(a) Where am I going? (b) How am I doing now? and (c) Where do I go next?—to support a learning cycle (Hattie & Timperley, 2007; Sadler, 1989). Therefore, the most important formative assessment practices involve (a) students' understanding of their learning target, (b) the criteria by which they will know how they are doing in achieving that target, and (c) the feedback they receive to help them understand next steps. Literature supports prioritizing these three dimensions of formative assessment.

The Assessment Work Sample Method Program

The Assessment Work Sample Method (AWSM) is a professional development program that builds middle school math teachers' understanding of the characteristics of high-quality formative assessment and increases their ability to use it. We were inspired to create AWSM following the results from previous research (Randel et al., 2011) on a program that did not change teacher practice in mathematics in part because it had few math examples. By contrast, AWSM provides professional development that builds formative assessment practices and skills specifically in math. The AWSM approach, adapted from a language arts study (Clare, Valdés, Pascal, & Steinberg, 2001; Matsumura et al., 2006), incorporates authentic student work samples that help ground teacher learning in daily practice. The work samples include a cover sheet that conveys the teacher's intended learning goals for the lesson, the type of student knowledge or skill to be developed, the criteria for meeting learning goals, and general information that will help reviewers understand the "what and why" of the assignment. Attached to the cover sheet are four pieces of student work, two pieces of work that met the teacher's intended learning goals and two pieces of student work that did not meet the intended learning goals. Professional development participants refine their understanding and skill for implementing formative assessment as they discuss these work samples, recommend revisions to improve the work sample, and connect the work sample to their own instructional practice.

The AWSM professional development is structured around nine face-to-face meetings, which include a two-day introductory workshop and eight sessions of about 45 minutes each. During part one of the introductory workshop, participants build their understanding of formative assessment as an instructional process. The connection of formative assessment to personalized learning begins to unfold as participants discuss why and how to create a positive classroom culture. They compare a growth-oriented mindset, the belief that intelligence can be developed (Dweck, 2006), to a fixed mindset, the belief that intelligence is static, and discuss implications for student perseverance on complex tasks. Participants also learn about the physical, social, and emotional factors that impact classroom culture. Figure 1 depicts the three AWSM dimensions with positive learning environment at the center.

Figure 1. AWSM Dimensions



In part two of the workshop, participants plan to implement formative assessment by examining authentic student work because it is in student work that student thinking is made visible (e.g., Hattie, 2009). In collaborative groups, teachers analyze the intended learning goals, success criteria, and student tasks from anonymous work samples to determine if these lesson elements are strongly aligned, partially aligned, or weakly aligned. Mathematical content as well as the inferred cognitive demand of both the learning goal and student task are reviewed and discussed. Through this analysis, participants clarify their understanding of AWSM Dimension 1 (learning goals and aligned student task) and Dimension 2 (success criteria; see Figure 1). These dimensions are considered the foundation for the formative assessment process because without clarity about what is to be learned and clear criteria for goal attainment, the feedback process can be derailed. Figure 2 is an excerpt from a work sample used in AWSM. It shows part of the teacher's cover sheet, the formative task, and one piece of student work.

Figure 2. Work Sample Used in AWSM

Teacher Cover Sheet

5. What were your learning goals for the students for this assignment? In other words, what skills , concepts, or facts did you want students to learn, practice or demonstrate understanding of as a result of completing this assignment? (Students will know and understand that: ...)

   I wanted students to demonstrate an understanding of unit rates and be able to calculate unit rates fluently ... or be able to make comparisons when the rates were not the same.

6. Check the type of learning goal/target this assignment addresses (check all that apply):
   - [x] Knowledge (facts/details to be memorized)
   - [x] Skill (algorithmic procedures)
   - [x] Conceptual Understanding (reasoning, generalizing, explaining, etc.)
   - [x] Problem Solving within a Context (multiple procedures; solution strategy)

11. a. How was this assignment assessed? If there is a rubric, student reflection, etc., please attach it. If you are not attaching a rubric, please explain your criteria for determining if students met the learning goal of the assignment.

    The rubric is attached (on back of assignment) and shows the assignment is worth a total of 5 points (which I doubled and told the students I would do ahead of time).

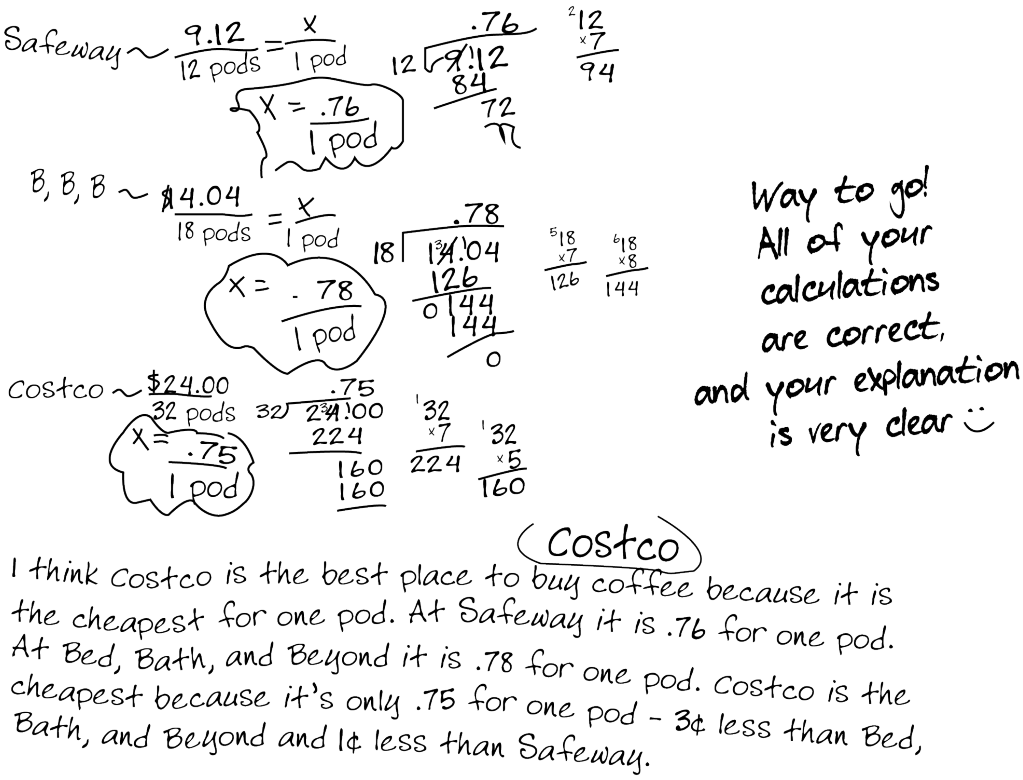
11. b. Did you share these criteria with the students? [x] Yes [ ] No

3	2	1
Student shows an accurate comparison of costs of coffee pods at each of the three stores by calculating unit rates or other common ratios.	Student shows an accurate comparison of costs of coffee at two of the three stores by calculating unit rates or other common ratios.	Student calculates only one correct unit rate or common ratio.
	Student gives a clear written explanation for where the coffee should be purchased.	Student gives an unclear (or incorrect) written explanation for where the coffee should be purchased.

Formative Task

Mrs. H always tries to find the best deals in town before making purchases, especially when it comes to coffee (because she buys and drinks a lot of it)! She shops at several stores around Denver, including Bed, Bath, and Beyond, Safeway, and Costco. As she stops by each of these three stores this weekend, she takes note of the prices they are currently charging for pods of French Vanilla Coffee. Safeway is currently carrying her favorite brand in a box that comes with 12 pods for $9.12. Bed, Bath, and Beyond is selling the same brand, but their box is slightly larger (comes with 18 pods) and costs $14.04. Finally, she notices that Costco is also selling that brand and comes in a much larger box with 32 pods for a cost of $24.00. Where should Mrs. H buy the coffee and get the best deal in town? Please show your work and explain your thinking in the space below. You must give a mathematical and written explanation to convince Mrs. H.

Student work



The eight short sessions are organized as teacher learning communities (TLCs) with a facilitator who has both mathematics and formative assessment expertise. The first five sessions focus on Dimension 3 (descriptive feedback), and are structured to build teacher knowledge and skill for providing effective oral and written feedback to students. Participants learn that

feedback should be based on stated learning goals and success criteria established in Dimensions 1 and 2 and that general statements, such as, "Good job" or "Work harder," do little to move student learning forward. Teachers also learn to resist providing student feedback which is too specific. At times, mathematics teachers provide step-by-step notations on how to correct an inaccurate solution. Unfortunately, this practice keeps the responsibility for learning with the teacher rather than with the student, whereas providing feedback that uses cues ("Remember our work with similar figures."), questions ("How do you know the area is equivalent?"), and recommendations for next steps ("Check your notes from Tuesday.") helps students determine next-step actions and thus take more responsibility for their own learning.

In Dimension 3, teachers also learn that students should be active partners in the feedback process, and it is through this process that the self-directed aspect of personalization is incorporated. It's important to note that Dimension 3 is dependent on the clarity of criteria developed in Dimensions 1 and 2. These dimensions help teachers craft lessons that demonstrate clear alignment between the learning goal, student task, and success criteria, and this criteria is explicitly communicated to students. In Dimension 3, students gauge their own progress toward the learning goal by participating in peer- and self-assessment activities using the criteria developed in Dimension 2. Participants in AWSM implement peer- and self-assessment practices through an incremental process beginning with whole class activities, partner activities, and self-assessment activities. In the whole group activities, students compare a sample of work from an anonymous student to a set of criteria. Through discussion of the work sample, students begin to identify student work that meets or does not meet a set of criteria. As students develop skill for assessing work based on criteria, they participate in peer-assessment (feedback) activities. These activities tend to begin with identifying the presence or absence of criteria and then progress toward assessing a peer's work for solution accuracy and quality of student response. In each case, student assessors identify both strengths and recommendations for improvement based on established criteria. Teachers monitor this process and use whole group debriefing activities to make sure students receive accurate feedback from peers. This process is designed with the ultimate goal of empowering students to objectively assess their own work based on a set of criteria so that they can monitor and adjust their own learning strategies to reach intended learning goals.

During the last three short sessions, AWSM participants bring work samples from their own students to share with colleagues. These TLC sessions offer a safe environment for teachers to discuss problems of practice and refine their own implementation of formative assessment.

Connections to Personalized Learning

Although AWSM was not intended to study personalization per se, comments from teachers during focus groups revealed a connection between the strategies espoused by AWSM and aspects of personalized learning. For example, teachers noted that classroom culture, particularly teacher–student relationships and student–student interactions, were more positive as implementation of formative assessment strategies became the norm. They also made comments that align with the personal competencies (cognitive, metacognitive, motivational, and social/emotional) described in *Through the Student's Eyes: A Perspective on Personalized Learning* (Redding, 2013). In focus groups, teachers reported that students responded to formative assessment strategies with increased motivation, engagement, and persistence in math. Teachers reported that clearly

communicated learning goals and success criteria helped clarify their teaching and let students know what they should expect to learn. Furthermore, having clear learning goals and success criteria facilitated communication with students and parents, thus strengthening teacher–student–family relationships. Teachers indicated that formative assessment data helped them plan activities for students at various levels of mastery.

Teachers reported that engaging students in peer- and self-assessment activities increased student awareness of success criteria and developed a heightened sense of individual accountability for learning. For example, teachers gave students tracking sheets with success criteria to use in self-assessing their level of understanding relative to the learning goal so they could monitor their progress. One teacher said, "They'll start on what they know, but then they actually take ownership of saying, 'Oh, I haven't mastered this.' And then they start testing their own learning."

At most schools, teachers said they were using peer assessment extensively. They described having students partner to discuss their approaches to homework problems or to go over in-class activities. One teacher commented that this technique made it easier for students to get help when they were reluctant to seek help from the teacher. Some teachers were initially concerned that students would be unkind to one another during peer feedback, and this turned out to be a problem when peer feedback was given in written, anonymous form. However, when teachers then tried structured, face-to-face peer assessment, it worked well: "I find when they verbally [provide] feedback to their peer, they're much nicer, it's more constructive, and it's actually a lot more helpful." When students gained experience with peer assessment, they participated in productive social interactions, and as student interactions progressed, teachers were more willing to reorganize classroom configurations and use flexible grouping strategies. More effective use of formative data also allowed teachers to differentiate student assignments so that students were assigned tasks specific to their learning needs, thus resulting in a more personalized learning experience for students.

...having clear learning goals and success criteria facilitated communication with students and parents, thus strengthening teacher–student–family relationships.

Teachers in the AWSM study reported the same problems with student motivation for math (difficulty with engagement and persistence, especially with challenging problems) as reported by other teachers in the literature. Their students also were reluctant to be wrong, to show work, and to do work that was ungraded. The AWSM professional development program emphasized the role of class culture for a growth mindset and de-emphasized accurate solutions as the only measure of progress in mathematics. It helped teachers clarify learning goals and the criteria by which student progress would be measured. Additionally, it helped personalize learning through differentiated activities and empowered students to become partners in learning. At the conclusion of the study, participants shared some thoughts on the AWSM process:

- "I used to think formative assessment was about the teacher knowing where students are in the learning process. Now I know that formative assessment must include students so that they understand how to improve their own learning."
- "I used to think I had to grade everything. Now I know I can provide descriptive feedback and allow students to take action."

- "It's the dimensions of clear learning goals and success criteria that have most impacted my instruction. I think I was always clear about what was being learned, but I needed to be more explicit about sharing this information with my students."

AWSM investigators considering the next steps for this work intend to include more direct connections to the personal competencies of student cognition, motivation, and perseverance.

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