PRACTICAL FORMATIVE ASSESSMENT STRATEGIES FOR 6-12 STUDENTS

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Two educational practices that have a significant impact on student learning, and can be implemented in every classroom immediately, are giving feedback and providing formative evaluation (Hattie, 2017). Formative assessment involves eliciting evidence from students, giving feedback to push learning forward, and adjusting instruction based on the evidence of students' learning. By shifting the focus of assessment away from ranking students and toward building students up as mathematicians, formative assessment also has the potential to help develop a strong mathematical identity for all students.

The purpose of this article is to explore some of the literature related to formative assessment in the mathematics classroom, and to share practical, effective formative assessment strategies that can be implemented immediately by mathematics teachers.

Formative Assessment Research and Literature

In a recent Education Week article, Tom Vander Ark summarized how Rick DuFour's work on professional learning communities (PLCs) relates to formative assessment. He states, "the four critical questions of a PLC include: 1. What do we want all students to know and be able to do? 2. How will we know if they learn it? 3. How will we respond when some students do not learn? 4. How will we extend the learning for students who are already proficient?"

The first of these questions involves setting goals, or learning targets, for students. The second question involves assessment, which includes both formal and informal assessment of students' learning needs. The third and fourth questions involve adjusting instruction based on what is learned about students through daily formative assessments. For example, in a lesson on solving equations,

the learning target may be, “The learners will solve two step equations”. A learning check may occur part way through the lesson to formatively assess the students’ ability to solve two step equations. If students have not yet met this target, further examples would be shared. If students demonstrate the ability to meet this target, more complex equations would be offered.

James Popham, in his book *Transformative Assessment* (2008), takes the idea of using formative assessment to adjust instruction to the next level by reflecting on the potential for classroom and school-wide shifts in beliefs related to formative assessment. As teachers use formative assessment strategies more in their classrooms, students adjust how they perceive assessment. This shift in student beliefs leads to greater shifts in classroom and schoolwide culture related to Popham lists four levels of formative assessment implementation in classrooms and schools. In level one, teachers use formative assessment to collect evidence in order to adjust instruction. In level two, students use formative assessment to adjust their learning. In level three, classroom culture changes from assessments for grades to assessments for evidence and learning. In level four, there is a schoolwide culture change centered around assessments for student learning and growth (p.ix).

Dylan Wiliam explains this culture shift from using assessments for grades to using assessments for student learning and growth in his seminal book on formative assessment, *Embedded Formative Assessment* (2011). In it he states that “Feedback functions formatively only if the information fed back to the learner is used by the learner in improving performance.” (p.120). He also cites studies that compare the effectiveness of giving students a score on a test, compared to giving students a score and feedback. Surprisingly, “the effect of giving both scores and comments was the same as the effect of giving scores alone.” (p.109). It is only when constructive feedback is given in the absence of

a score or a grade that we see students use that feedback constructively and the quality of their work improves.

Recent NCTM documents have built on this knowledge base and helped to frame formative assessment in the broader picture of high-quality mathematics teaching practices. *Principles to Actions: Ensuring Mathematical Success for All* (2014) offers eight mathematics teaching practices that need to be components of every mathematics lesson. The eighth of these is that teachers need to "Elicit and use evidence of student thinking". PtA states, "Effective teaching of mathematics uses evidence of student thinking to assess progress toward mathematical understanding and to adjust instruction continually in ways that support and extend learning." (p.10). *Catalyzing Change in High School Mathematics: Initiating Critical Conversations* (2018) takes the next step to match the eight mathematics teaching practices to equitable teaching practices. These equitable mathematics teaching practices support students' identities in their classrooms. The mathematics teaching practice, "elicit and use evidence of student thinking," is directly related to the following three equitable teaching practices (p.34):

- Elicit student thinking and make use of it during a lesson to send positive messages about students' mathematical identities.
- Make student thinking public, and then choose to elevate a student to a more prominent position in the discussion by identifying his or her idea as worth exploring, to cultivate a positive mathematical identity.
- Promote a classroom culture in which mistakes and errors are viewed as important reasoning opportunities, to encourage a wider range of students to engage in mathematical discussions with their peers and the teacher.

Formative assessment used in the mathematics classroom has the power to not only elicit evidence from students, offer feedback to those students, and inform the teacher's instruction, but to develop and build a positive mathematical identity for all students. This is a powerful shift in the classroom culture from using assessment as a ranking tool to using assessment as a means to build students up as mathematicians; and to creating a school culture where teachers, students, and parents focus on learning and not on grades.

Four practical classroom formative assessment practices will now be examined through this lens. Each of these strategies will highlight a way to use assessment as a vehicle to build students' identities by focusing on student learning.

Practical Formative Assessment Strategies

My Favorite No

The first practical formative assessment strategy that will be shared is called, "My Favorite No" or "My Favorite Mistake". This strategy was made popular by a video posted on The Teaching Channel in 2011 (https://learn.teachingchannel.com/video/class-warm-up-routine). Leah Alcala, a middle school mathematics teacher in California, shared this warm-up routine that allows her to use her students' mistakes to clarify mathematical misconceptions. Using this every day with our students is a wonderful way to identify students' misconceptions, address those misconceptions, and adjust instruction accordingly.

Here's how it works. Students are asked to solve a math problem on an index card or on scratch paper. The teacher collects the students' work, and then quickly scans through to identify a favorite mistake. This isn't always the most common mistake or the greatest misunderstanding, but it is usually one that highlights an important mathematical concept. The teacher then shares this

anonymous work on the whiteboard or using a document camera. Students are then asked to identify what was done well, followed by what was done incorrectly.

When using this method, it is important for the teacher to scan through the students' work publicly so the students can see that the work and answer that is shared with them is authentic student work from one of their classmates. It is also important to start by having the students identify what was done well before analyzing the mistake. This allows the discussion to build on the good work rather than simply criticizing what was done incorrectly. Using questions such as, "what would you tell this student if you were trying to help them with this problem" frames the mistake in a positive light and builds a classroom culture where mistakes are celebrated and used as opportunities to learn, while also building students' identities as mathematicians by having them see themselves as resources for other students. Another important practice is to publicly recycle the notecards or scratch paper immediately following the discussion. This helps eliminate students' fears of being held accountable by a grade and builds an environment of learning from their mistakes without the fear of being negatively graded.

Using this method offers many benefits to both the teacher and the students. The teacher is able to quickly ascertain the general understanding of the entire class. This fits the formative assessment feedback cycle because it allows the teacher to decide whether to go ahead with the plan for the day, or to adjust instruction based on the volume of student misconceptions. Students are able to make mistakes in a safe environment and learn from their mistakes and those of their classmates. Jo Boaler, in her book *Mathematical Mindsets* (2016), writes about how students' brains grow the most during times of struggle, and that when students are wrong, they remember the correct answer for longer. A lasting benefit of this method is that when students analyze their mistakes in a safe

learning environment, they avoid making those same mistakes later. Common mistakes on summative assessments are lessened or eliminated when those same types of mistakes have previously been addressed in class using authentic student work.

The equitable teaching practices from *Catalyzing Change* are demonstrated in this warm-up. The teacher elicits student thinking, makes student thinking public, and promotes a culture in which mistakes and errors are viewed as important reasoning opportunities. When students see formative assessment as an opportunity to solidify and deepen their conceptual understanding of a topic, there is great potential for them to build their identities as mathematicians.

Monitoring Student Work During Instruction Based on Anticipated Responses

This practical formative assessment strategy seems simple, yet it is very powerful. This strategy is initiated during the planning stages of any lesson and implemented during any student work time during a lesson, whether that time is dedicated for students to complete one problem or multiple problems.

When planning problems or tasks for students to complete individually or in groups, teachers should always do the assigned problems in advance. While doing these problems, teachers should anticipate the common mistakes that students will make. For example, if the students are asked to do the following problem:

Find the equation of the line in slope-intercept form that passes through (3, -3) and (9, 7).

The first step is often to find the slope between the two points. This slope is equal to 10/6 or 5/3. A common mistake students might make is to subtract the x values in the numerator and the y values in the denominator, giving a slope of 6/10 or 3/5. When planning a lesson, the teacher should make note of these common errors.

When teaching a lesson, the teacher needs to deliberately walk around the entire room during work time and look over every student's shoulder to see their work. There is likely not enough time for the teacher to scan every student's entire work; however, if the teacher knows the common mistakes to look for, they can scan relatively quickly looking only for this specific mistake. In the previous example, if the teacher sees a value of 6/10 or 3/5 on a student's page, they know that they should stop and assist that student. Otherwise, they move on to other students in the class. Teachers need to know in advance what common mistakes to look for in order to check in with every student multiple times per class period.

The teacher needs to take each individual class's needs and individual students' needs into account when planning and anticipating student mistakes. For the previous problem, perhaps the most common error will look completely different or will appear at a different point in the problem. The teacher needs to take account of the students' previous assessments, the learning target for the day, and what has been previously observed in the classroom when anticipating student mistakes.

One additional benefit to this is that if the teacher were to see multiple students have the same misconception, the teacher could make immediate adjustments to the lesson to address the needs of a large group of students or an entire class. This is also a reminder to every teacher that monitoring students during work time is a wonderful opportunity to connect with students and address misconceptions immediately as they occur. A teacher who is not engaged in monitoring individual students during student work time is missing a tremendous teaching and learning opportunity.

Monitoring students' work gives the teacher a good feel for what the students know and are able to do. Including the anticipation of common mistakes in one's plans is actually easier when done

in conjunction with My Favorite No, because the teacher remembers common mistakes that students make and starts to anticipate those mistakes in advance.

Students' mathematical identities are built during the use of this strategy because mistakes and misconceptions are addressed immediately, and the teacher is able to check in with every single student multiple times during each class period. Additionally, student learning and understanding is the demonstrated goal of in-class work, not earning a grade or earning points.

Vertical Non-Permanent Surfaces

This formative assessment strategy can be used many different ways during the teaching of a lesson or during student review time and fits well with the previous strategy of monitoring student work. Peter Liljedahl, in his article "Building Thinking Classrooms" (2017), shares research regarding vertical non-permanent writing surfaces, or VNPS's. A VNPS could be a permanent whiteboard, a mobile whiteboard, a window, or a sheet of white tile board. Dry erase markers work well on all these surfaces. If possible, a classroom should be surrounded by vertical writing surfaces and students should use them often.

In his article, Liljedahl shares benefits to having students work at VNPS's. When comparing students who worked vertically vs. students who worked at their desks horizontally, he found that students who worked vertically took less time to get on task, were more eager to work, discussed the task more, and participated more. Working vertically activates the students' brains and being on their feet allows active learners to focus on their task.

When comparing students who worked on non-permanent surfaces (whiteboards) vs. students who worked on paper, Liljedahl found that the students working on the non-permanent surfaces also took less time to get on task, were more eager to work, discussed the task more, and participated

more. When writing on a whiteboard, students were more apt to jump right in to a problem and were not afraid to make mistakes. Perhaps the ability to instantly erase their mistakes gave them confidence to try something, as opposed to the students writing on paper whose work was more difficult to erase.

One additional benefit of using VNPS's in the mathematics classroom is that it allows the teacher to see student work as it happens. The teacher should move throughout the room addressing misconceptions as they occur, allowing the students' learning to move forward rather than building on their misconceptions. A further benefit is that students don't even realize they are being informally assessed by their teacher, which eliminates the fear of making mistakes. Another benefit is that students can look at other students' work when they are stuck, or they can compare work and/or answers when they have completed a problem. This instant student-to-student feedback assists students and allows them to see their peers as resources to help them learn, while also building them up as resources for each other. Formative assessment in this example shifts from teacher-directed learning to student-directed learning, which builds the classroom culture as a safe place to learn and builds students' identities as learners and teachers.

Post-Test Reflections

The three previous formative assessment strategies are implemented by teachers during their planning and/or teaching of a lesson or unit. The fourth strategy is a means of offering feedback on a summative assessment, while also allowing further learning opportunities to students after the summative assessment has occurred.

When students receive a test back, the first thing they look at is their grade. The second thing they look at is their friend's grade. Some teachers attempt to change this by writing constructive

comments on students' tests in order to help the students continue their learning even after the test. Unfortunately, as Dylan Wiliam has stated, comments given along with grades are often ignored as the focus is still on the grade or score from the assessment (p.109). The only way to change the focus of a summative assessment from a ranking tool to a learning tool is to include comments in the absence of grades. In fact, Jo Boaler has stated that math teachers who replace grading with constructive written comments increase students' learning (Boaler, 2017).

To help turn a summative assessment from a grading tool into a learning tool, first use comments throughout the assessment to help students learn from their mistakes. These may be as simple as circling an incorrect step, and as prescriptive as writing the steps to solve a problem. Even more importantly, a score or grade should never be written at the top of the test, otherwise students will not learn from the comments teachers took the time to write. Instead, teachers should leave the top of the test blank so that the focus of the students can be on the written comments throughout the test.

The second way to turn a summative assessment into a learning tool is to use a self-reflection sheet (Figure 1). This tool is handed out to the students prior to handing back the students' tests. Students are asked to reflect on their preparation, as well as on their understanding of the mathematical concepts. On the back of the self-reflection sheet, students are required to copy any problem they did incorrectly on the test, re-do the problem correctly, and briefly write what they should have done on the assessment. When students are done, they turn in both their self-reflection sheet and their test, and the teacher uses the students' work to gauge their understanding of the material (Figure 2).

Test_____ Name_____

POST TEST SELF REFLECTION

In this unit, what percentage of the homework did you do on time?_____

About how much time did you spend studying for this test?_____

What letter grade do you believe you deserve on this test?_____

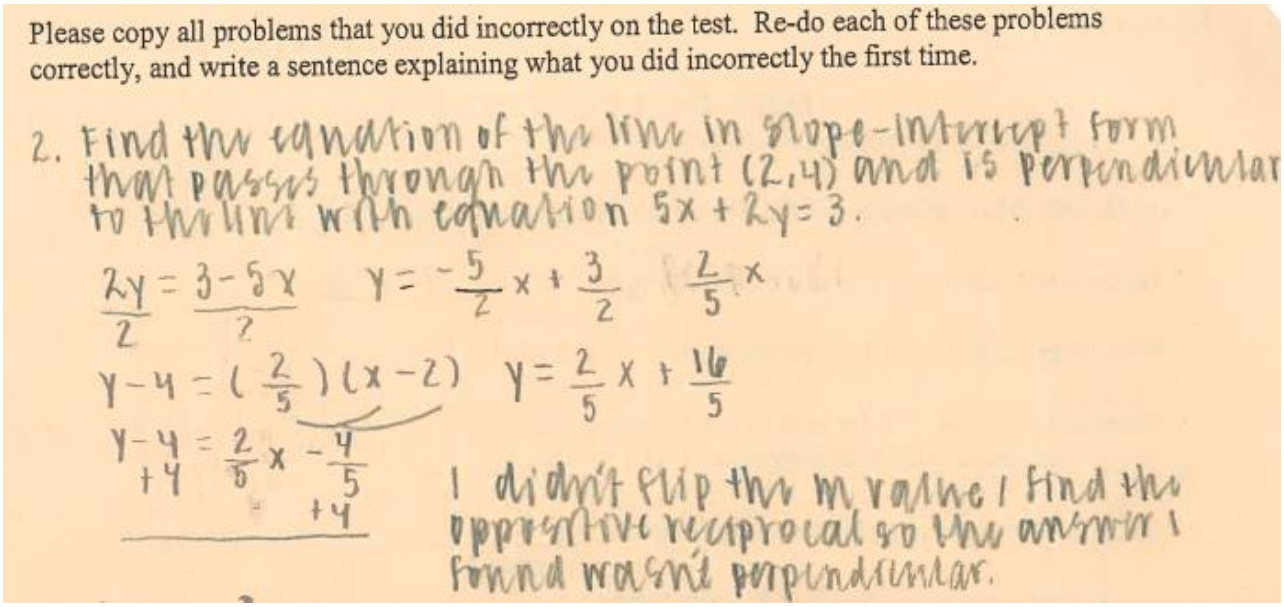
What did you do to prepare yourself for this test? Be specific.

Are there big ideas on this test that you didn't understand? Explain.

Does your performance on this test reflect your knowledge? Explain.

On the back of this sheet, please copy all problems that you did incorrectly on the test. Re-do each of these problems correctly, and write a sentence explaining what you did incorrectly the first time.

Figure 1. Every student completes this self-reflection sheet prior to receiving their previous test.


Please copy all problems that you did incorrectly on the test. Re-do each of these problems correctly, and write a sentence explaining what you did incorrectly the first time.

2. Find the equation of the line in slope-intercept form that passes through the point (2,4) and is perpendicular to the line with equation $5x + 2y = 3$.

$\frac{2y}{2} = \frac{3-5x}{2}$ $y = -\frac{5}{2}x + \frac{3}{2}$ $\frac{2}{5}x$

$y - 4 = (\frac{2}{5})(x-2)$ $y = \frac{2}{5}x + \frac{16}{5}$

$y - 4 = \frac{2}{5}x - \frac{4}{5}$

$+4 \quad +4$

I didn't flip the m value / find the opposite reciprocal so the answer I found wasn't perpendicular.

Figure 2. This is a sample of a student's self-reflection on a problem they previously did incorrectly.

It is up to the teacher whether to assign points to this reflection or not. Whatever the teacher decides, it is important to explain to the students the importance of learning from mistakes, and the importance of completing this as a learning tool.

This formative assessment strategy builds students' identities as mathematicians by shifting the classroom culture from assessment for grading to assessment for learning. Students learn from their mistakes and become stronger mathematicians because of those mistakes.

Conclusion

Teachers and educational leaders know that formative assessment positively impacts student learning. Constantly eliciting evidence from our students, giving feedback to push learning forward, and adjusting instruction based on the evidence of students' learning is good pedagogy and should be a common practice in every mathematics classroom. Additionally, by shifting the focus of assessment away from ranking students and toward building students up as mathematicians, formative assessment

also has the potential to help develop a strong mathematical identity for all students. This article offers four easy-to-implement examples of the use of formative assessment in the mathematics classroom that will help shift the classroom culture from a focus on assessments for grades to a focus on assessments for learning.

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