Classroom-Based Formative Assessment Techniques to Guide Teaching and Learning

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Howard County Public Schools (MD)

Kansas MTSS Mathematics Conference • Wichita, KS
April 28, 2016 • 9:40-11:10 a.m.
Getting to Know You

• Where are you from?
• What do you do?
  – Mathematics Specialists / Instructional Leader?
  – Teachers?
    • Level?
      – Early childhood? Elementary? Middle? High?
    • Other? (e.g. special education, ESL, etc.)
  – Administrators?
    • Principal or Assistant Principal?
    • Supervisor/Curriculum Director?
  – Higher Ed? Mathematics Teacher Educators?
  – Consultants?
  – Other?
Howard County Public Schools
(Ellicott City, MD)

Our Mission
We cultivate a vibrant learning community that prepares students to thrive in a dynamic world.

Our Vision
Every student is inspired to learn and empowered to excel.

Goal 1 - Every student achieves academic excellence in an inspiring, engaging, and supportive environment.

Goal 2 - Every staff member is engaged, supported, and successful.

Goal 3 - Families and the community are engaged and supported as partners in education.

Goal 4 - Schools are supported by world-class organizational practices.
www.mathspecialists.org

ELEMENTARY MATHEMATICS SPECIALISTS & TEACHER LEADERS PROJECT

Supporting the ongoing work of Elementary Mathematics Specialists--professionals who know and understand mathematics, and who effectively lead and mentor their colleagues.

LOGIN OR JOIN

A PARTNERSHIP OF:

Brookhill Institute of Mathematics

ems&tl

McDaniel College
Meet and Discuss

When you’re around discussions related to *formative assessment*, what *actions* are typically described?
Classroom-Based Formative Assessments—Guiding Teaching and Learning

FRANCIS (SKIP) FENNELL, BARBARA ANN SWARTZ, BETH McCORD KOBETT, AND JONATHAN A. WRAY
And, also see NCTM’s *APME, 2015:*

*Classroom-Based Formative Assessments: Guiding Teaching and Learning*

Francis (Skip) Fennell, *McDaniel College, Westminster, Maryland*
Beth Kobett, *Stevenson University, Stevenson, Maryland*
Jonathan A. Wray, *Howard County Public Schools, Ellicott, Maryland*
Here’s what we will do today!

• Consider the intentional, regular use of particular classroom-based formative assessment (CBFA) techniques, and
• Recognize how the use of CBFA’s can truly guide both teaching and learning.
The classroom is your canvas...
NCTM Research Brief: Formative Assessment

a) Clarifying, sharing, and understanding goals for learning and criteria for success with learners;
   - pathfinder

b) Engineering effective classroom discussions, questions, activities, and tasks that elicit evidence of students’ learning;

c) Providing feedback that moves learning forward;

d) Activating students as owners of their own learning;

e) Activating students as learning resources for one another.

NCTM “Key Strategies” for Effective Formative Assessment.
The PLC Teaching-Assessing-Learning Cycle

**Step One**
Collaborative teams identify learning targets and design common unit tasks and assessment instruments.

**Step Two**
Teachers implement formative assessment classroom strategies.

**Step Three**
Students take action on in-class formative assessment feedback.

**Step Four**
Students use assessment instruments from step one for motivation, reflection, and action.

**Step Five**
Collaborative teams use ongoing assessment feedback to improve instruction.

Kanold & Larson, 2012
Linking assessment to planning and instruction is used to inform teaching and learning.
We actually know a lot about formative assessment...
• The term **formative assessment** has been with us for at least 70 years (e.g., Sueltz et al., 1946; Weaver, 1955)....

• Regular use of **classroom formative assessment** would raise student achievement by 0.4 to 0.7 of a standard deviation – enough to raise the U.S. into the top 5 countries in the international rankings for mathematics (Natriello, 1987; Crooks, 1998; Black and Wiliam, 1998).
Formative Assessment - Research

In an experimental design in which teachers regularly used formative assessment to drive instruction, their students made *almost twice as much progress over the year* as measured by externally scored standardized tests than their counterparts in other classrooms.

William, Lee, Harrison & Black, 2004
Evidence suggests that actual day-to-day use of formative assessment is not as prevalent in classrooms as one might expect (Stiggins, 2013).
And...

Aside from teacher-made classroom tests, the integration of assessment and learning as an *interacting system* has been too little explored.

Glaser & Silver, 1994
What we have done...

First, we recognized:

• an **overload** of publications, published assessments and services promising the *quick formative assessment fix*.

• a need to emphasize and enhance the use of classroom-based formative assessments – **to guide teaching and learning**.

So, we:

• Distilled seemingly endless suggestions and strategies to a **small pallet** of formative assessment **techniques**.
Interviews

Show Me

Observations

Hinge Questions

Exit Tasks
Observations

“We know it is more informative to observe a student during a mathematical activity than to grade his papers.”

Freudenthal, 1973, p. 84

Note: Many teachers indicate that observing is something they have always done, but have not seen it as a formative assessment technique, or they need support to use observations to explicitly guide and inform their instructional decisions.
Elena and her 3 friends ate 9 cookies. How many cookies did each friend eat?
Observation

Elena and her 3 friends ate 9 cookies. How many cookies did each friend eat?

- What would you hope to observe?
- How would you know it if you saw it?
- How might you record/note the observation?
- What misconceptions might you observe?
You be the judge...

Elena and her 3 friends ate 9 cookies. How many cookies did each friend eat?
Planning, Data Collection, and Reflection Tool: Observations

<table>
<thead>
<tr>
<th>Intent of the Observation</th>
<th>Brief description/comments</th>
<th>Observed?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics Content</td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Mathematical Practice(s)</td>
<td></td>
<td>Partially</td>
</tr>
<tr>
<td>Student Engagement</td>
<td></td>
<td>No</td>
</tr>
<tr>
<td>General Comment:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feedback to Students:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fennell, Kobett, & Wray, 2015
Observations

Observe students as you ask them to decide how many hops of 3 ¼ on a number line are closest to but < 9. Then observe students as they decide how many 3 ¼ number line hops are closest to but < 15.
# Planning (& Data Collection) Tool – Observations

<table>
<thead>
<tr>
<th>Mathematical Practice:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Key student dispositions:</td>
<td>Teacher actions (to promote student dispositions):</td>
</tr>
</tbody>
</table>

## Comments:
Observations

Observe students as you ask them to decide how many hops of 3 \( \frac{1}{4} \) on a number line are closest to but < 9. Then observe students as they decide how many 3 \( \frac{1}{4} \) number line hops are closest to but < 15.
Interviews

• Long history of use in mathematics and special education (Weaver, 1955; Ginsburg, 1997; Fennell, 1972, 1998).
• Takes time – focused; 1-on-1 or small group
• Allows you to dig deeper
• Not intended to be deficit-based
• Provides a glimpse into what a child is thinking
• Extends the observation.
Observation/Interview rec’s from a while ago!

• Observation, discussion, and interviews serve better than paper-pencil tests in evaluating a pupil’s ability to understand the principles he/she uses (Sueltz, Boynton, & Sauble, 1946, p. 145).

• Information is best collected through informal observation as students participate in class discussions, attempt to solve problems, and work on various assignments individually or in groups (NCTM, 1989, p. 233).

• Observation of the pupil’s oral and written work is a very important assessment procedure and should be encouraged. Closely associated with the use of observations is the interview with the pupil regarding his/her daily work or his solution or attempted solutions of items of a test (Spitzer, 1951, p. 191).
Supporting Mathematics Reasoning and Sense-Making Through Interviews

- What does this problem (solution) mean? Why does your method work?
- Did you solve the problem differently than your classmates? Are your solutions comparable?
- What are some of the decisions you made? Do agree or disagree with those decisions NOW?
- Did you use any models or other representations to help solve the problem?
- Does your answer make sense to you?
- Would you like to change something about your solution now that you have heard thought of other ideas?
- Are your explanations the same as anyone else's? How are they different?
Observations to Interviews

This is $\frac{7}{8}$ because I split the number line into 8 lines. Next, I put a circle on the 7th line. That represents $\frac{7}{8}$.

Interviews

• What would make you decide to work 1:1 with a student or small group?

• What questions might you ask? How might the questions be different?

• What will you anticipate from students? (Consider understandings AND possible misconceptions.)

• What follow-up questions might you ask?
Reflect and Share...

• Think of your work with <insert math content topic>
  – What are some areas of concern, where you just might want to interview students about their thinking?
  – Share your ideas here (e.g., Comparing Fractions – understanding the importance of the size of, or relationship to, the whole):

  tinyurl.com/interviews16

• How does this impact your planning?
  – Consider ANY aspect of your work with the selected mathematics content topic.
### Interview Prompt

<table>
<thead>
<tr>
<th>Assessing</th>
<th>Student Response</th>
<th>Feedback to Student(s)</th>
<th>Teacher Comments/Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conceptual Understanding</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Procedural Fluency</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Strategies Used</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Student Prerequisites and Misconceptions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disposition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Comment:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Adapted from Larson, Fennell, Adams, Dixon, Kobett, Wray, 2012 as cited in Fennell, Kobett & Wray, 2015, p. 55
Show Me

- A performance-based response to what a teacher observes.
- Combines elements of the observation and interview.
- A *stop-and-drop* activity where a student, small group of students or perhaps the entire class might be asked to show how something works, a problem solved, or a particular representation used.
Show Me

1. Provide a *show me* prompt that you might use for the following: *Compare two fractions with different numerators and denominators (e.g. 3/4 and 5/6) by creating common denominators or numerators or comparing them to the fraction benchmark ½.* *(4.NF.A.2)*

2. What might you want a student or students to *say* as they describe their *show me* response?

3. How is this (the *show me* CBFA technique) different from an interview or observation?

4. When might YOU use a *show me* in your own setting?
Show Me examples

• Show at least three equivalent fractions for \( \frac{1}{4} \) using a number line.

• Compare the fractions \( 3/4 , 5/6 \) and \( 7/8 \) using whatever representation you like.
Summing Up...

• **Observations** – Paying attention, monitoring

• **Interviewing** – specifics, “I want to know more about what I just observed.”

• **Show Me** – This is an explicit performance of what I would like to see demonstrated.
Hinge Questions

Hinge questions provide a check for understanding/proficiency at a ‘hinge-point’ in a lesson, or stated differently, success of the lesson hinges on responses to such questions as they provide an indication of whether the teacher can move from one important idea/concept/skill to the another (or not). Such responses impact both planning and instruction.
Think of your colleagues and their use of questioning...

What comes to mind?

Can you picture a colleague who is adept at questioning? Describe them.

Can you think of a colleague (perhaps me) who struggles with questioning?
“... For many teachers, diagnostic questions are most useful in the middle of an instructional sequence to check whether students have understood something before moving on. The central idea here is that the teacher designs each lesson with at least one “hinge” in the instructional sequence. The hinge is the point at which the teacher checks whether the class is ready to move on through the use of a diagnostic question.” (Wiliam, 2012)
Our take on the hinge question

- Hinge questions provide a check for understanding/proficiency at a ‘hinge-point’ in a lesson.
- Success of the lesson hinges on responses to such questions as they provide an indication of whether the teacher can move from one important idea/concept/skill to the another (or not).
  - Ideally students should respond within **one minute** and teachers be able to analyze and interpret responses within **fifteen seconds** (2011, p.101).
- Hinge question responses impact both planning and instruction.
Hinge Question

I walked 2 \( \frac{3}{4} \) miles on Monday, Tuesday, and Wednesday. Have I walked more or less than 10 miles? How do you know? How far did I walk?
## Hinge Question Planning Tool

<table>
<thead>
<tr>
<th>Hinge Question:</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Will the hinge question assess important mathematical understandings of the day?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Will students understand the question?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Will students be able to respond in about a minute?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Will expected responses be such that they can be analyzed and interpreted quickly?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General consideration: Will responses assist in shaping planning for tomorrow’s lesson? (circle one) YES NO (if no, revise hinge question)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**HOW?**

Fennell, Kobett & Wray, 2015, p. 58
Types of Hinge Questions

1. Can you name a fraction that is greater than $\frac{3}{4}$?

2. Which of the fractions below is $> \frac{3}{4}$?
   A. $\frac{1}{4}$
   B. $\frac{1}{2}$
   C. $\frac{4}{4}$
   D. $\frac{3}{5}$

Note the differences – both regarding responses and creation and use.
Guidelines for Developing/Selecting Hinge Questions

1. Design hinge questions that elicit the right response for the right reason.

2. When using multiple choice (selected response) items, *incorrect answers* should be *interpretable*.

3. Sometimes it makes sense to administer a hinge question as a series of simple questions (used with *Every Pupil Response*).

Source: Wiliam, 2015
Principles for Using Hinge Questions

1. Get a response from every student.
2. Do a quick check on understanding, instead of engaging in extended discussions.
3. On the basis of student responses, decide whether to go forward or back.

Source: Wiliam, 2015
Thoughts on this one?

\[ \frac{7}{2} \div \frac{9}{5} = ? \]

- an integer, like 6
- a *proper* fraction, like \( \frac{1}{2} \) or \( \frac{6}{10} \)
- an *improper* fraction, like \( \frac{10}{7} \) or \( \frac{14}{8} \)
- a mixed number, like \( 1 \frac{3}{4} \)

Source: https://www.khanacademy.org/math/arithmetic/fractions/div-fractions-fractions/e/dividing_fractions_1.5
“My Favorite No” (AKA - One of my favorite low-tech formative assessment techniques)

Source: Teaching Channel on Youtube, 2011
https://www.youtube.com/watch?v=Rulmok_9HVs
Exit Tasks

• The exit **task** is designed to provide a capstone problem or exercise that captures the major focus of the lesson of the day. This is a class assessment tool, and like the hinge question, student responses to the exit task help in identifying needs and in the planning for the next day’s lesson.

• See handout for more information.
Bree’s Pizza Palace has to load boxes of cheese. Each box weighs 5 ¾ pounds. There were 4 boxes. Was the total weight < or > 25 lbs.? Write a response to show how you know.
Here’s another...

The fractions below indicate how much of a race each tricycle has completed. Make a prediction and compare the predicted order of finish.

1/2  1/4  5/6  2/3
Year long pilot – with teachers...

Q: Has working with the CBFA’s made a positive impact on your work with teachers?

• 1-5 rating scale
  (1) Strongly disagree ...................... (5) Strongly agree
• Mean rating: 3.78
• Median rating: 4
• n = 32
Year long pilot – CBFA’s and planning

Q: Can you now claim that teachers consider classroom based formative assessment as they plan lessons for teaching mathematics?

- 1-5 rating scale
  - (1) Strongly disagree .................. (5) Strongly agree
- Mean rating: 3.30
- Median rating: 3
- n = 33
Year long pilot – CBFA’s and teaching

Q: Can you claim that teachers regularly (as in every day) use classroom based formative assessment as they implement mathematics lessons.

• 1-5 rating scale
  
  (1) Strongly disagree ..........................  (5) Strongly agree

• Mean rating: 3.32

• Median rating: 3

• n = 31
Summing Up

**Interviews**
- Recorded; used to guide/monitor what’s going on...

**Observations**
- As needed 1-1 or small group; “I want to know more about what I just observed.”

**Show Me**
- An explicit performance of what I would like to see demonstrated.

**Hinge Questions**
- Every lesson’s “deal breaker”

**Exit Tasks**
- Hinge Question + Exit task (next day’s plan!)
Formative assessment is:

• Students and teachers,
• Using evidence of learning,
• To adapt teaching and learning,
• To meet immediate learning needs,
• Minute-to-minute and day-by-day.

Love this…

Thompson and William, 2007
Assessment Resources...

• Illustrative Math Project - [http://illustrativemathematics.org](http://illustrativemathematics.org)

• Institute for Mathematics and Education – University of Arizona; Bill McCallum - [ime.math.arizona.edu](http://ime.math.arizona.edu)

• Dana Center and Agile Mind: Common Core Tool Box - [http://ccsstoolbox.org](http://ccsstoolbox.org)

• Mathematics Assessment Project (MAP) - [http://map.mathshell.org](http://map.mathshell.org)
And...

NCTM’s Annual Perspectives in Mathematics Ed 2015: Assessment to Enhance Learning and Teaching

ALSO - Assessing Math Everyday: 5 Classroom-Based Techniques That Work! (Corwin, 2017)
Thank you!

Slides/Handouts:
http://jonathanwray.com