Erin Marie Furtak
June 7, 2017

Formative Assessment and Instructional Materials

A description or definition of the focus area nominated

Formative assessment is broadly considered as the process by which teachers draw out and respond to student thinking in the course of instruction. In the 2001 supplement to the *National Science Education Standards*, the NRC defined formative assessment as consisting of three steps: teachers setting goals, eliciting student thinking, and then providing feedback to move learners ahead. This definition is widely accepted in not just science education, but across content areas. Much research has been done on formative assessment since Black and Wiliam's (1998) claim that it could narrow achievement gaps between lower and higher-performing students while raising achievement for all students.

Recently, Randy Bennett (2011) described formative assessment as a 'thoughtful integration' of tasks and processes; I have come to a definition that is an expansion of this perspective (Furtak & Heredia, 204) in which we consider formative assessment *tasks*, or the instructional materials that teachers use to draw out student thinking while learning is in progress; formative assessment *practices*, or the activities in which teachers and students engage for the purpose of drawing out and responding to student thinking, as well as formative assessment *participants*, which are usually the teacher and students. This distinction is useful because if instructional materials attend only to creating tasks but not attending to the practices and participation structures in which these materials are used, it's not clear if they will be used to give feedback to help students learn about what they know, what they have to learn and how to move forward.

When it comes to prepared instructional materials, it's useful to think about embedded formative assessment tasks as one type in a universe of different kinds of formative assessment materials. Embedded tasks are different from, for example, formative assessment strategies like 'stoplighting' or 'popsicle sticks' that can be used in any content domain (Keeley, 2008). Rather, embedded tasks pay attention to the scope and sequence of a given curriculum context, and are crafted with specific questions and prompts that draw out student thinking relevant and relative to what students have just learned, and where they are headed.

An explanation of why this focus area is of critical importance for instructional materials in science

I like to use a metaphor from the movie 'The Hunt for Red October' when I think about the importance of embedding formative assessment tasks within instructional materials. There is a scene in the movie where Jack Ryan realizes that the Russian navy is not actually looking for a missing submarine, but trying to drive it in a particular direction; he knows this because they are sending out sonar pings but moving so quickly through the water that they're not waiting to hear back from the pings that would tell them the location of the submarine. Instructional materials without formative assessment are the same way – they're designed to drive students in a particular direction without waiting to find out what students might know now, and creating space to pull in those ideas to inform instruction.

The thing is, it's really, really hard to write a good formative assessment task; Paige Keely's NSTA books are popular because she spends a lot of time thinking about common student prior ideas in a domain, and constructing specific, open-ended questions to draw out student thinking. A good embedded formative assessment task draws on rich literature on a domain, and provides students with a context in which to think about the scientific ideas or practices that are being assessed.

A brief description of what it might look like in practice (i.e., how one knows it is present in a set of instructional materials)

In my research, as well as in that done by Hosun Kang and colleagues, we've attempted to develop frameworks for thinking about formative assessment. I'm going to again make the distinction between task design and classroom practices here, because they are not the same, but are critically intertwined with each other.

In terms of instructional materials or tasks, we can think about the structure of a task in terms of how it is designed to draw out student thinking. Kang and colleagues (2014) identified a set of different types of scaffolds for formative assessment tasks in the context of their studies of ambitious science teaching; she found that the following types of scaffolds helped to draw out quality explanations that could then serve as the 'meat' of formative assessment: using contextualized phenomena, checklists, rubrics, sentence frames, and explanatory models in combination with written explanations.

In my own research, my team has come up with sets of criteria to describe quality formative assessment tasks that include the extent to which there is space for students to express their thinking, whether questions on the assessment are open- or closed-ended, and the extent to which the information students provide on the assessment can be easily interpreted (Furtak et al., 2016). Recently, we've added criteria that include the extent to which the question is phrased in the context of a phenomenon (e.g. asking students to explain why balloons appear to float instead of asking them about forces and vectors).

Once teachers have given students a formative assessment task, they might pause to interpret the student work and think about next instructional steps (e.g. Heritage et al., 2009). For tasks embedded in instructional materials, this might involve going through student work and making judgments about the extent to which students have learned what they need to know in order to move on, or harvesting students' language and models to inform where an instructional sequence might go next, as is the case in responsive teaching (Richards & Roberts, 2016).

Thinking about the types of practices that go with these tasks is a different matter. Whereas I've found in my research that quality formative assessment tasks can help teachers organize their classroom practices around particular questions to surface student thinking (e.g. Furtak, 2012), there are also instances where teachers seem to have great formative assessment practices even when the tasks they're using are not that open-ended; in contrast, teachers can quickly shut down student reasoning to a quality open-ended question, or fail to give students feedback that can

guide them forward in a productive fashion (Furtak et al., 2008). Kang and colleagues (2016) saw variations in the ways that teachers launched tasks in their classrooms as well.

These results suggest that instructional materials should also focus on how teachers can use tasks in their classrooms, rather than just providing tasks that can be copied and handed out to students. Creating space for students to share their ideas and respond to each other can actually function to have the feedback happen in the course of regular instruction, rather than being something a teacher comes up with overnight or between classes. The idea of an 'assessment conversation,' a term coined by Duschl and Gitomer (1997) captures this – an opportunity to listen to others' thinking and to refine ideas.

I think about formative assessment practices as examples of authentic questions when teachers are drawing out student thinking as a starting point for working with their ideas, and making inferences about what students know. These inferences are complicated, and based upon what teachers know about the content and student thinking; thus another recommendation would also include guidance to a teacher, alongside a formative assessment, of common ideas that might come out. However, it doesn't end there; it also consists of teachers and students (and students and students) pushing each other in their thinking (Windschtil et al., 2012), and providing helpful and informational feedback in some cases that help students improve (Hattie & Timperley, 2007). Giving this kind of thoughtful and tailored feedback is very challenging, so suggestions in instructional materials about what to do next are also extremely helpful (e.g. telling a teacher if her students have a particular type of response on a formative assessment, what the next instructional experience might have to inform those ideas to develop them further).

The challenges and opportunities associated with these criteria

We know from studies of practice that formative assessment tasks can support ambitious science instruction (e.g. Kang et al., 2014), and that they take time and careful thought to write well. Thus, there is tremendous potential to get more and better questions asked of students by embedding formative assessment tasks in instructional materials.

However, just because the tasks are there doesn't mean they will be used as intended, or used at all. Some guidance about how to embed tasks in classroom practices and participation structures that get all students to share their thinking, and to listen to each other are important; providing suggestions about how combinations of students writing and talking can surface a larger range of ideas (Furtak & Ruiz-Primo, 2008).

We also know that teachers can support each other in looking together at student work and thinking about how to proceed given particular types of tasks. Thus instructional materials might also consider giving suggestions for processes for teachers to bring student work together around common (i.e. used across classrooms by multiple teachers) embedded formative assessment tasks, to sort student responses into different piles, and to discuss what the students in those piles seem to think and how to support each of those students in subsequent instruction.

References

Bennett, R. E. (2011). Formative assessment: a critical review. *Assessment in Education: Principles, Policy & Practice*, *18*(1), 5–25.

Black, P., & Wiliam, D. (1998). Assessment and Classroom Learning. *Assessment in Education*, *5*(1), 7–74.

Duschl, R. A., & Gitomer, D. H. (1997). Strategies and Challenges to Changing the Focus of Assessment and Instruction in Science Classrooms. *Educational Assessment*, *4*(1), 37–73.

Furtak, E. M. (2012). Linking a learning progression for natural selection to teachers' enactment of formative assessment. *Journal of Research in Science Teaching*, *49*(9), 1181–1210.

Furtak, E. M., & Ruiz-Primo, M. A. (2008). Making Students' Thinking Explicit in Writing and Discussion: An Analysis of Formative Assessment Prompts. *Science Education*, *92*, 799–824.

Furtak, E. M., & Heredia, S. (2014). Exploring the Influence of Learning Progressions in Two Teacher Communities. *Journal of Research in Science Teaching*, *51*(8), 982–1020.

Furtak, E. M., Kiemer, K., Circi, R. K., Swanson, R., de León, V., Morrison, D., & Heredia, S. C. (2016). Teachers' formative assessment abilities and their relationship to student learning: findings from a four-year intervention study. *Instructional Science*.

Furtak, E. M., Ruiz-Primo, M. A., Shemwell, J. T., Ayala, C. C., Brandon, P., Shavelson, R. J., & Yin, Y. (2008). On the Fidelity of Implementing Embedded Formative Assessments and its Relation to Student Learning. *Applied Measurement in Education*, *21*(4), 360–389.

Hattie, J., & Timperley, H. (2007). The Power of Feedback. *Review of Educational Research*, *77*(1), 81–112.

Heritage, M., Kim, J., Vendlinski, T., & Herman, J. (2009). From Evidence to Action: A Seamless Process in Formative Assessment? *Educational Measurement: Issues and Practice*, *28*(3), 24–31. http://doi.org/10.1111/j.1745-3992.2009.00151.x

Kang, H., Thompson, J., & Windschitl, M. (2014). Creating Opportunities for Students to Show What They Know: The Role of Scaffolding in Assessment Tasks. *Science Education*, *98*(4), 674–704.

Kang, H., Windschitl, M., Stroupe, D., & Thompson, J. (2016). Designing, launching, and implementing high quality learning opportunities for students that advance scientific thinking. *Journal of Research in Science Teaching*, *53*(9), 1316–1340.

Keeley, P. (2008). *Science Formative Assessment: 75 Practical Strategies for Linking Assessment, Instruction, and Learning*. Thousand Oaks, CA: Corwin.

Keeley, P., Eberle, F., & Farrin, L. (2005). Assessment Probes: Uncovering Students ' Ideas in Science. *Science Scope*, January, p. 18-21.

National Research Council. (2001). *Classroom Assessment and the National Science Education Standards*. Washington, D.C.: National Academy Press.

Richards, J., & Robertson, A. D. (2016). A Review of thre Research on Responsive Teaching in Science and Mathematics. In A. D. Robertson & R. E. Scherr (Eds.), *Responsive Teaching in Science and Mathematics* (pp. 36–55). New York, NY: Routledge.

Windschitl, M., Thompson, J., Braaten, M., & Stroupe, D. (2012). Proposing a core set of instructional practices and tools for teachers of science. *Science Education*, *96*(5), 878–903.