THE FEEDBACK LOOP

Using Formative Assessment Data for Science Teaching and Learning

ERIN MARIE FURTAK

HOWARD M. GLASSER

ZORA M. WOLFE

Hawker Brownlow
EDUCATION

CONTENTS

CHAPTER 1

Overview of the Feedback Loop

I use a lot of formative assessments, but I feel like I don't really appropriately analyze the data that I gather or use it for reteaching purposes in the most effective way.

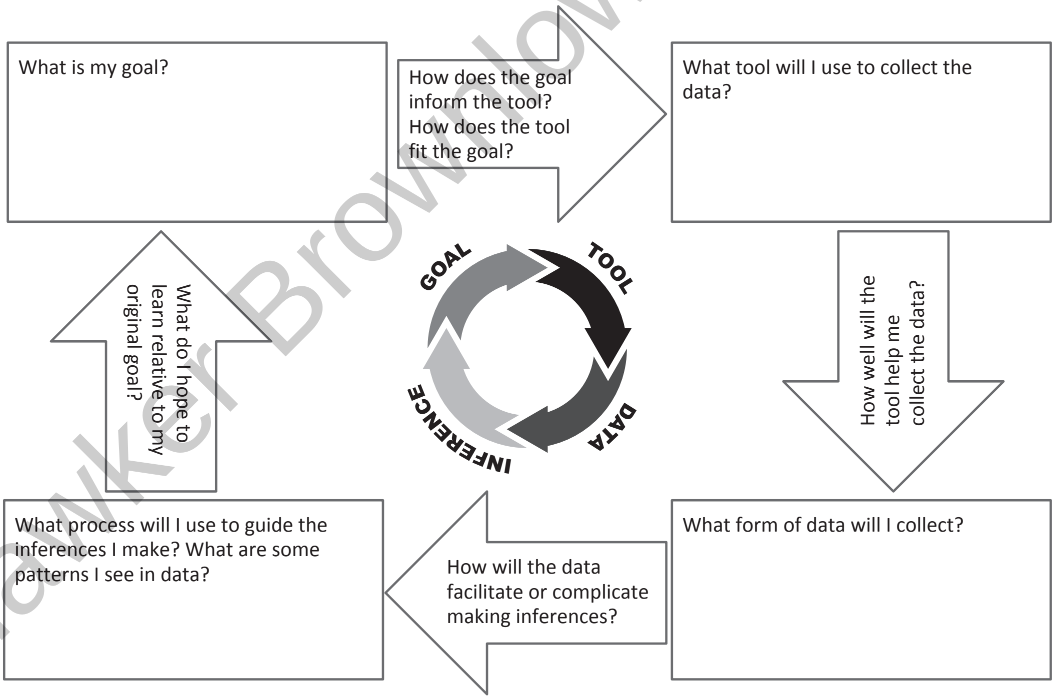
—Beginning high school science teacher

Science teachers today are subjected to a deluge of data in their daily work. They are expected to draw on these data to make decisions about what to do during instruction. This trend, often called *data-driven decision making*, is the subject of big policy initiatives in schools right now. The amount of data coming at teachers *is* overwhelming. Let's take the case of an average public school secondary science teacher, who might be teaching upward of 150 students in five different classes a day. Although all of those classes might be repeats of the same course (e.g., eighth-grade physical science), it's more likely that the teacher has at least two different types of courses to teach. Given the current accountability system, it's likely that the students participate in standardized tests one or more times a year, yielding some kind of information for the teacher to interpret during or at the end of the school year. On a more immediate level, all of these students will be completing assignments and assessments daily or weekly. Although data is often confined to some type of written response, valuable data about student learning comes in many other formats, both formal and informal. Student comments during classroom discussions, the written work they generate—from lab reports to verbal responses to worksheets—and even student expressions and emotions can be considered data and can fill in gaps about what students know and are able to do in ways that test scores miss.

making inferences about the quality of teaching and learning; however, we contend that thinking about the data along with the goals, tools, and inferences will ultimately help you feel *less* overwhelmed by the information collected. That is, rather than swimming in a pile of paperwork or feeling lost in the midst of a classroom conversation, you will go in one direction of the framework to consider how these data connect with goals. If the data are not aligned with goals, maybe you don't need to make inferences about it at all. Or, maybe your tools need to be adjusted so that the data you generate allow you to make better, more efficient inferences about what students know.

The Feedback Loop pushes us to consider the connections between the different elements, as shown in Figure 1.3. While a first step for a teacher might be to identify goals, tools, data, and inferences, the questions listed in the arrows in Figure 1.3 can help you evaluate the entire process of data collection and interpretation.

FIGURE 1.3 Connections between elements of the Feedback Loop



The first connection between the goal and tool asks how a given goal informed the selection of a tool and how the tool fit the goal. The next connection raises the question of how well the tool helped you collect the data, and the third connection highlights how particular pieces or sets of data facilitated or complicated making inferences. Finally, the last connection between the inferences and goal help you evaluate what was learned with respect to the original goal that drove the process of data collection and interpretation.

A Staircase Progression in a Non-*NGSS* State

The administrators at Vasquez* Middle School asked their seventh-grade science team to develop common formative assessments for their astronomy unit and to use those assessments as ways to track student learning. The science teachers at Vasquez, like those at many schools in the United States, have several resources that they can pull from to help them plan assessments, including state standards and assessment frameworks, school district pacing guides, and the curriculum their school has adopted.

Vasquez is located in a non-*NGSS* state; however, its state standards integrate science practices with disciplinary core ideas. Its standards for astronomy in middle school note that students should model the relative positions of the Earth, the Moon, and the Sun and use this model to explain observable effects such as eclipses and Moon phases. Performance expectations for students in eighth grade note that, to score at the second-highest level of proficiency, students should be able to relate phenomena such as eclipses and lunar phases to rules governing the solar system.

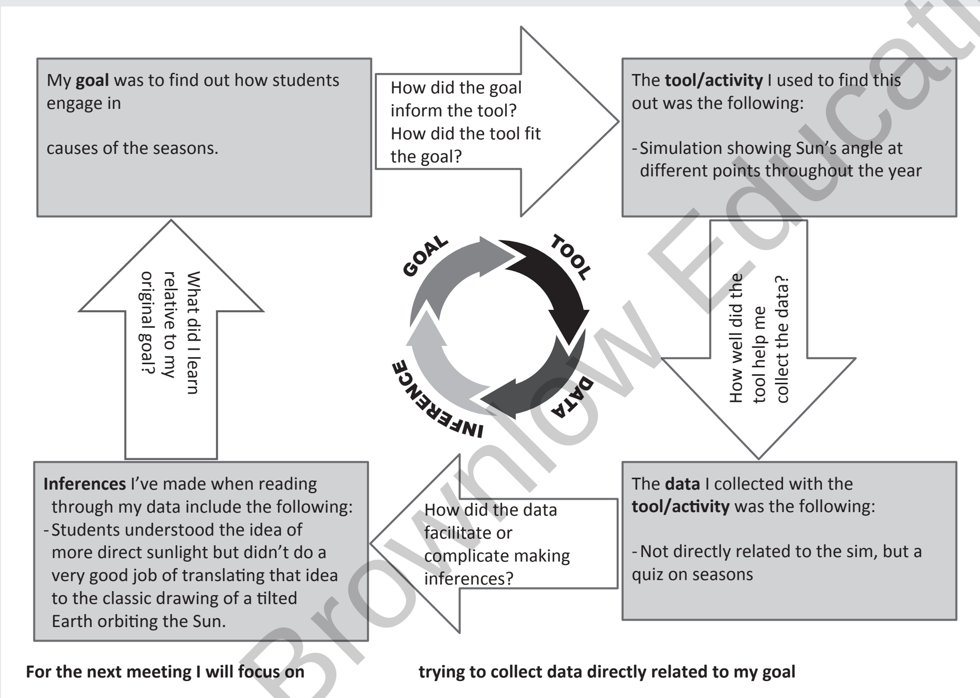
The school district has placed learning about the Earth, the Moon, and the Sun at the eighth-grade level, and to support students in learning about their standards, it has adopted the Project-Based Inquiry Science (PBIS) curriculum, which is framed around Big Questions, which orient learners to the essential ideas in science, and Big Challenges, which guide instruction (IAT 2010). PBIS textbooks include sequences of instruction that build logically to help students answer the Big Questions described in each learning set.

After learning about the Feedback Loop in a district-sponsored professional development meeting, the science teachers at Vasquez gathered these resources to design a common formative assessment. They set their sights on a unit that was several weeks away in which student would engage with a series of models to support them in learning about the relative positions of the Earth, the Moon, and the Sun. The teachers would bolster this instruction with Learning Set 2 from PBIS-Astronomy, which engages students in a series of investigations of physical models of these three bodies.

* This and all other school and teacher names marked with an asterisk are pseudonyms.

Mr. Carlson's reflection on his design and enactment of this activity is summarized in the feedback loop he completed during the professional development meeting (Figure 3.2).

FIGURE 3.2 Mr. Carlson's original feedback loop



After Mr. Carlson had walked his small group through his feedback loop, the facilitator noted that, for the next meeting, Mr. Carlson was going to try "to collect data directly related to [his] goal." She asked Mr. Carlson to share his thoughts about his experiences.

Facilitator: It seems like, based on what you have written down here, you have information on what the students know, but you feel like it wasn't completely related to the goal. Can you unpack that a little more?

Mr. Carlson: This [Figure 3.1] is the quiz I gave. So, I found that students did pretty well on the multiple-choice and the true or false. But they had a lot of trouble on this drawing.… The thing that I thought was interesting was that students confused B and D. Which, if anything, the misconception that the drawing gives is that A and C are closer and that the orbit isn't circular. But students still flip-flopped B and D.… There was some data that suggested that students did have an idea of the cause of the seasons in terms of more direct sunlight versus less direct sunlight causing them. But that classic drawing, that didn't tell me what they got from the simulation because the simulation was all about the view from Earth.

CHAPTER 4

Collecting Data

I have data! Now, how should I use it?

—First-year high school chemistry teacher

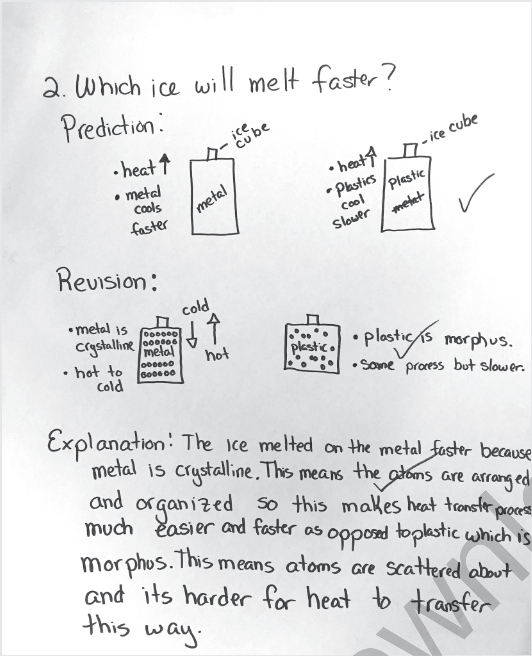
Say the word *data* to a science teacher and certain images may come to mind, such as spreadsheets, tables, graphs, or lists of numbers. These forms of data are part of the everyday experience of practicing scientists. Depending on the type of science we're talking about, data might also include field notes of animals' behavior, drawings, maps, or samples such as tree and ice cores, rocks, or blood. Our backgrounds in science lead us to call these forms of data most immediately to our attention.

At the same time, the word data is floating around educational reform circles. Everywhere you turn, it seems as if some form of data is being collected and then used as a foundation for a new catchphrase policy; for example, "data-driven instruction" or "data-driven decision making." A recent New York Times article (Rich 2015) summarized this trend:

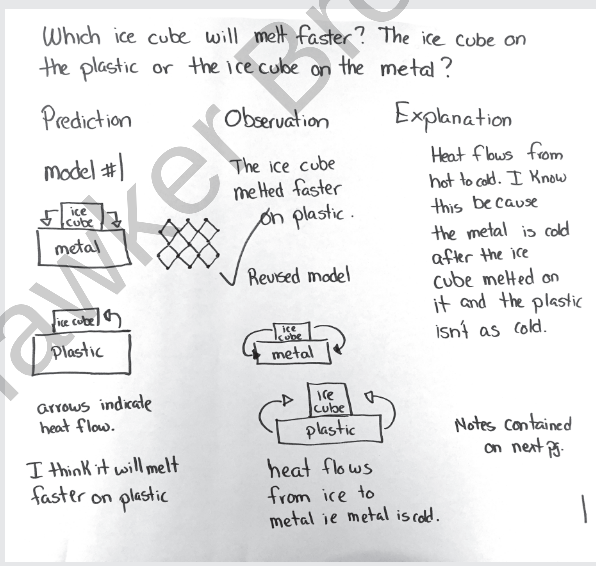
> *Custodians monitor dirt under bathroom sinks, while the high school cafeteria supervisor tracks parent and student surveys of lunchroom food preferences. Administrators record monthly tallies of student disciplinary actions, and teachers post scatter plot diagrams of quiz scores on classroom walls. Even kindergartners use brightly colored dots on charts to show how many letters or short words they can recognize.*
>
> *Data has become a dirty word in some education circles, seen as a proxy for an obsessive focus on tracking standardized test scores. But some school districts, taking a cue from the business world, are fully embracing metrics, recording and analyzing every scrap of information related to school operations. Their goal is to help improve everything from school bus routes and classroom cleanliness to reading comprehension and knowledge of algebraic equations.*

FIGURE 4.7 Sample student models: (a) student A; (b) student B

a.



b.



After engaging in this process of making inferences from the multiple sources of data and having students reflect on their own learning, I finished the class period with one final tool, a clicker question intended to help me get a sense of how well students had moved toward the correct explanation through the activity:

Which is at a higher temperature inside a car on a hot summer day?

a. The cloth seat covers

b. The metal buckle of the seat belt

c. Both the cloth seat covers and metal buckle of the seat belt are at the same temperature.

The data were not comforting. Students drew on their everyday experiences to answer the question; because the metal feels hot to the touch but the cloth seat cover does not, over 70% of students responded that the metal seat belt buckle would be at a higher temperature. But something interesting then happened. Only when students saw the right answer did they make a connection between the previous ice cube activity and the clicker question. Students were then quick to explain that the heat was flowing from the (warm) metal seat buckle to the (cooler) hand, just as heat flowed from the (warmer) metal block to the (cooler) ice cube. I inferred that this question also gave students an opportunity to see that heat was not the same as temperature. Everything inside the car was at the same temperature, but only the conducting materials efficiently transmitted the heat, thereby making them "feel" hotter.

CHAPTER 6

Closing the Feedback Loop

Feedback means hearing them. It means, especially when we're in a discussion, affirming all of their ideas … hearing what they're saying and maybe rephrasing it in more … words that are science words instead of maybe more colloquial words. It also means when I make a mistake or they make a mistake, this didn't work, how come? Maybe we didn't do this correctly. Maybe we need to look at this again. Feedback also means acknowledging what's not working but in a way that doesn't threaten them as people.

—Alice Schafer*, middle school science teacher

This book is about a process for planning and reflecting on formative assessments in secondary science classrooms, and we call it a loop for a reason: Once you've gone through each of the four main steps in the process, the idea is to connect the inferences you've made back to the goals. This process of closing the loop is often called feedback in the formative assessment literature (Black and Wiliam 1998) or, put more simply, using the information you've gained in your trip through the loop to move students forward in their learning (Ruiz-Primo and Furtak 2006, 2007; Shepard 2000).

While the term *feedback* can sound a little abstract, we like to think about it as something that effective teachers use every day when they are being responsive to information about student thinking. But, research into feedback has clearly identified approaches to responding to student thinking that are more and less effective at influencing student learning (Hattie and Timperley 2007).