Reasoning and Making Mistakes Like a Good Scientist

by Rebecca Grainger

A Disconnect in the Value of Failure

Scientists are inquisitive. The practice of science encourages deeper thinking, engaging in questioning, and the continuous seeking of information. A failed attempt or "wrong" answer does not stop the inquisition; rather it pushes the investigation further, deeper, perhaps in a new direction. Failed attempts push the field forward. If we hold the ability to persevere and problem solve as merits valuable to a scientific thinker, then we in turn should be engaging students in this practice. But are we?

A common type of talk that I see in the science classroom is Initiation-Response-Evaluation (IRE)—a teacher-posed question offered to the group with a particular response expected. Most expected responses are isolated facts, with the connection between facts being made by the teacher. The expectation is that as students regurgitate isolated facts and hear the teacher-led verbal connections, the students form an understanding of the content. But does a deep understanding truly result? And if so, does this classroom practice mirror the experiences and skills we hope to provide students entering the field of science? Even broadly put, does this practice help prepare all students for life beyond the classroom?

In 2010, Adam Grant and Francesca Gino published "A Little Thanks Goes a Long Way: Explaining Why Gratitude Expressions Motivate Prosocial Behavior"[1]. Grant and Gino conducted four experiments, in each asking individuals to provide help to others. In some instances the helpers received gratitude from the individuals benefiting from their help. All helpers, both those who received gratitude and those who did not, were asked to do a second task to observe the effect of receiving gratitude on providing future help. In all four of the experiments, the helpers that

[1] http://francescagino.com/pdfs/grant_gino_jpsp_2010.pdf

received an expression of gratitude were more likely to provide help in the future. Additionally, Grant and Gino's findings "suggest that when helpers are thanked for their efforts, the resulting sense of being socially valued, more than the feelings of competence they experience, are critical in encouraging them to provide more help in the future."

Strikingly, the sense of being socially valued, more than feelings of competence, drives increased participation.

Valuing Student Voices

Participation in student-to-student talk is a key factor in developing deeper evidence based discourse in the science classroom. If we support the idea that failed attempts are valuable to further the field of science, our classroom communities must mirror this belief. And, in doing so, we must:

- provide safe environments where such things as failed attempts to solve problems, faulty reasoning, errors of various sorts—often expressed in student-to-student discussions—are viewed as valuable to the learning process and inevitable on the road to true understanding;
- view all focused contributions to classroom dialogue as a means to strengthen the knowledge of the entire community; and
- value and encourage developing student voices, especially in student-to-student discussions, with simple expressions of gratitude.

This is a much different message than we are currently communicating using IRE. In discourse conducted through IRE, the message being conveyed is that the teacher voice is the voice of knowledge and therefore the most valuable voice in the class dialogue. The student voice is valuable only when delivering a right response held to be correct by the teacher and supported by established facts.

To increase the depth of knowledge expressed by students, we must communicate that we value a different type of class dialogue with students' contributions. Everyone in the class benefits when students' contributions push their current understandings of isolated facts into coherent arguments and explanations, backed with the practice of citing relevant evidence and articulating strong reasoning. The teacher's voice certainly has a place in this type of classroom dialogue. But rather than being the sole provider of knowledge, the teacher's voice can best serve students by posing cognitively challenging questions, by creating opportunities for all students to talk with each other in response to those questions, by probing for clarifications and evidence, and by establishing a community of learners who create, test, and extend knowledge.

We all enter the classroom with biases. Regardless of our intentions, we have predisposed expectations of students based on past experiences. Our biases have the ability to affect how we interact with students. If we view all students' contributions as valuable, we can begin to push all students and ourselves towards a classroom science community where students work, talk, and write like scientists in training.

Gratitude is not expressed in isolation. The giver of thanks is affected, as is the receiver. Studies show that both parties are affected in positive ways. Changing discourse in the science classroom is not an overnight fix, nor is it easy. When students talk up the challenges of this work, we must acknowledge to them and to ourselves that it will inevitably include such things as errors of various sorts. This is vital to what it means to be a scientific thinker. We must be realistic in our approach as we transform one-way teacher talk into opportunities for all students to solve problems together. I suggest we begin with gratitude.