# Productive Scientific Discourse

*Learning about science* often occurs at a personal level — a person can individually learn about science by reading, listening to lectures, and watching videos. *Practicing science,* more often than not, is a social endeavor — an activity that groups of people engage in together. And as with most social endeavors, discourse is an inherent part of this work.

Productive scientific discourse furthers both speakers' and listeners' understandings of scientific facts, ideas, and concepts and their ability to engage in science practices. When engaged in productive scientific discourse, people typically explore points of confusion, build off each other's ideas, wonder about each other's discoveries, grapple with challenges, analyze data to understand what its meaning, develop and evaluate models, debate the meaning of evidence, and craft explanations.

While productive scientific discourse is commonplace within the discipline of science, historically it has been a rarity in science classrooms. Science classrooms have often been places where students passively learned a set of things which humankind had already discovered. Students read about known science content, listened to teachers' lectures about science content, and watched videos in which science content was explained. Science content was delivered and students were expected to remember it.

In today's science classrooms, there is a push for engaging students in the practices of science. Because discourse is an essential part of how science is done, it must become an essential part of science learning.

## Types of scientific discourse

Not all scientific discourse sounds the same. It can be helpful to sort scientific discourse into two categories — exploratory and explanatory.

- *Exploratory discourse* is the type of discourse people have as they are generating data, brainstorming ideas, conducting investigations, wondering about what they observe, developing models, and mucking around as they start to make sense of phenomena in the natural world.
- *Explanatory discourse* is the type of discourse people have as they are making claims, supporting explanations with evidence, arguing for and against ideas, refining models. applying a critical, skeptical lens to evaluate explanations, and refining explanations.

## Supporting exploratory discourse

When supporting exploratory discourse, it's often helpful to call attention to areas that have not yet been noticed, offer reassurance, and provide additional data, images, and hands-on supplies when students get stuck. You can also encourage them to think about other interpretations and to attend to patterns and anomalies in the data. As a teacher, you might say things such as:

- I see you've talked about X. Have you had a chance to think about Y yet?
- When I first saw this image, I totally missed X. Did you all see that?
- What was one interesting thing you talked about?
- I hear you all wishing you had a picture of the animal and its habitat to go along with this reproduction data. Let's look for that info.
- I hear you've identified one pattern (or one anomaly). Are there any others?
- It sounds like you think that data point is an anomaly. What do you make of it?
- Wow! Did you see that?

## Supporting explanatory discourse

When supporting explanatory discourse, it's helpful to encourage participants to use evidence, logical reasoning, and scientific principles to support their claims. They should also think about how their explanations are similar and different, analyze the strengths and weaknesses of ideas, and examine how they might refine their thinking.

Explanatory discourse tends to be more challenging for students and it's easy to think that making it easier for students will improve the quality of their conversations. However, embracing the high

cognitive and linguistic demands of explanatory discourse tends to make conversations more engaging, more meaningful, and most importantly, more productive for students.

As you work to support your students engaging in explanatory discourse, you might say things such as:

- Using words may not be the most effective way to explain that idea. Maybe drawing a diagram would improve your communication.
- It sounds like you're a little unsure of your idea. What other data do you wish you had access to? Where could you find such data?
- What other evidence, reasoning, or scientific principles do you know about that might support that explanation?
- What feels precise and accurate about that idea (and what feels less solid)?
- Does everyone agree with every aspect of that explanation? If not, can you spend some time talking about where you have differing ideas?
- It sounds like you think that idea is promising. How might your group suggest making it more complete, accurate, and precise?
- I'm hearing you disagree with that idea. Who can share a specific argument against it?
- Sounds like your group is having trouble following an organized train of thought. Try thinking of a way to organize your ideas and evidence.

## Argumentation versus discourse

Argumentation involves discourse, but is not the same as discourse. According to the NRC Framework, "Argumentation is a process for reaching agreements about explanations and design solutions . . . Scientists and engineers engage in argumentation when investigating a phenomenon, testing a design solution, resolving questions about measurements, building data models, and using evidence to evaluate claims." Argumentation involves reading, writing, discourse, math, and modeling.

Pinning down exactly what the term argumentation means is difficult, and it's even harder to know just what it looks like in action and how to support it happening. We have found that taking a simple approach to argumentation and equating it to the process of sense making is helpful.

Formal presentations of explanations are not the same as argumentation. Explanations are well-supported answers that typically result from good argumentation. Argumentation is not just the act of presenting your best thinking and models to others.

STEM Teaching Tools explains this difference eloquently: "Argumentation involves a level of uncertainty — one argues to clarify for herself or to persuade others who have a different idea. A measure of uncertainty is powerful for constructing open-ended, authentic investigations for a class. Focusing on explanation and ignoring argumentation may inhibit such investigations. If this intellectual work is only framed for students as explanation, then the classroom process of exploring and testing different student ideas through evidence-based argument may not happen. Explanation can easily only focus on finding the 'right answer' — rather than developing an understanding of the conceptual ideas."