Using Teacher Talk Moves to Help Students Talk Like Scientists

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Science teachers are working to understand and align their lessons to the *NGSS* and its three dimensions: science and engineering practices, disciplinary core ideas, and crosscutting concepts (NGSS Lead States 2013). Classrooms are buzzing with students engaging with complex natural phenomena from the world around them. Creating these classrooms requires an understanding that student talk, collaboration, and a supportive learning community are critical. Students approximate the way scientists write about their work, speak with other scientists, and talk to advance their ideas within their own laboratory communities.

This talk is not just about claims, evidence, and reasoning; it forms patterns of talk (i.e., norms) that support students in talking with one another in ways that progress their understanding. These norms can be described as *progressive discourse* (Bereiter 1994), and define community talk as that which focuses on seeking evidence, sharing new ideas, building on others' ideas, and expressing understanding. For a teacher, this means creating a learning environment where these are the classroom norms, requiring thinking beyond the individual questions they ask their students.

Teacher talk moves are useful for supporting students' learning, but they are not enough to create a science learning community in the classroom. Talk moves focus on functional engagement with individual students' ideas and sensemaking. Norms must be established by having a nuanced understanding of how those individual talk moves create patterns of talk that become the natural way the class operates. This article discusses how talk moves can support larger norms of classroom science talk and provides examples of these kinds of classroom talk from a high school classroom.

Patterns of science talk

Learning in a science classroom is a social and cultural experience that must be built on student participation. Over time, scientists have informally established patterns of talking with each other, sharing ideas, and building on each other's knowledge when developing new ideas in science. These are the norms of science talk. In a classroom, talk moves are those questions or prompts teachers use to approximate and facilitate authentic forms of student science talk (Michaels and O'Connor 2012; Windschitl, Thompson, and Braaten 2018). For example, talk moves can be used to prompt students to justify their thinking, engage with other students' ideas, seek more information, or expand or explain their ideas. These teacher talk moves are responsive to student talk, and focus on helping students improve and expand their thinking. Some examples of talk moves can be found in Table 1.

In an *NGSS*-focused classroom, talk moves support students' engagement with content in meaningful ways, but they also encourage students to interact with one another like scientists do, creating a community of science learners. Talk moves support students talking in scientific ways and help students make sense of the data they collect, ask questions, and connect ideas. While talk moves can keep students engaged, teachers need to be aware of how individual talk moves establish patterns of discourse in the classroom over time. In other words, talk moves create a collection of norms that can be self-sustaining, allowing students to support each other in science talk even without the teacher present.

The purpose of science talk

A teacher, through the use of talk moves (usually in the form of questioning), can support the development of expectations that are not only functional for accomplishing the tasks of the activities, but also purposeful in developing and reinforcing the norms of science talk. Functional questions target specific instances of students' ideas and thinking to help them move forward. For example, functional talk questions might ask about specific data, probe a weak bit of reasoning, or press on a connection between two ideas. Using these questions in a purposeful way expands the focus beyond individual ideas to include patterns of talk that support the whole community such as: Ideas are framed in empirically testable ways, or all ideas are open to critique by the community. Bereiter (1994) described a set of these norms in terms of progressive discourse that are the foundation of science as a community of practice: expansion, openness, empirical testability, and mutual understanding. These norms, which can be heard in conjunction with one another or as individual utterances, represent the underlying purposes of science talk in both authentic science contexts and so, by extension, science classrooms.

TABLE 1

Examples of talk moves used to scaffold the norms of science practices.

TALK MOVE	PURPOSE	EXAMPLE
Say more.	Follow up on or focus on a student's idea.	What makes you think that? Can you tell me more?
Are you saying … ?	Revoice or rephrase what the student said.	When you say ... , do you mean … ? So, what you are saying is ... .
Ask for evidence.	Press for examples and seek justification.	Does the data support your explanation? What made you say that? Why do you think that?
Crosstalk.	Scaffold chance for students to talk to one another.	Do you agree with what _____ said? Can anyone add on to what ____ said?

Note. These talk moves are adapted from Michaels and O'Conner (2012) and Windschitl, Thompson, and Braaten (2018). More examples can be found at https://ambitiousscienceteaching.org.

Talk moves create a collection of norms that can be self-sustaining, allowing students to support one another in science talk even without the teacher present.

Progressive discourse does not require all four norms to be present in every conversation all the time. Similarly, because the norms are *patterns* of talk, we cannot claim progressive discourse is happening based on one instance of talk or one conversation. Rather, what we hope to see is these norms becoming more and more prevalent as the students move through the semester in response to purposeful use of teacher talk moves. We define each norm below using examples of student talk.

Listening in to student talk: Recognizing progressive discourse in action

Our example of what it sounds like for students to engage in progressive discourse comes from a midwestern high school Earth science classroom. However, no set of examples can perfectly exemplify all the possible ways progressive discourse is realized. Our purpose is not to show a complete sample, but rather to demonstrate the contrast between student talk to accomplish a task and student talk to participate in science. The students of this class worked in pairs on a shared laptop. They discussed ideas and answers as they worked through an online module, taking turns typing into the answer boxes. The excerpts found in Table 2 (see Online Connections) are from recordings captured while a pair of students are working on a plate tectonics module. The module is built around a data visualization tool, Seismic Explorer (SE) (Figure 1), which uses real-time USGS data documenting earthquake depth and magnitude as well as historic data of volcanic eruptions (Smithsonian 2013). The module also has a simulation tool called Tectonic Explorer (TE) (Figure 2) that uses an "Earth-like" planet to allow students to simulate and observe plate motion and interactions along plate boundaries.

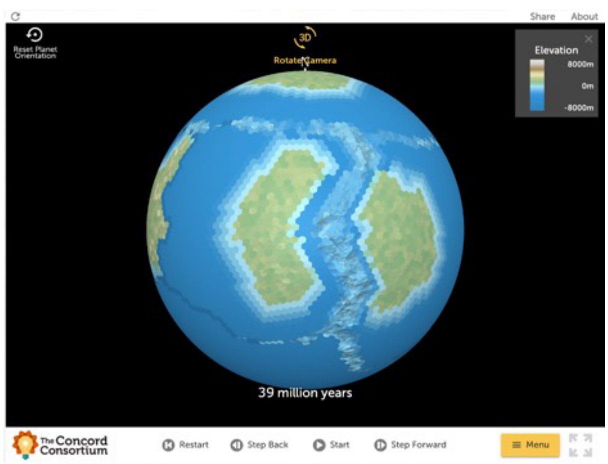
In the examples found in Table 2, the students are completing an activity in which they engage with global GPS data of plate motion (Smithsonian 2013). For the second activity they use SE to explore the formation of the Andes mountains and the Aleutian Islands and begin to develop a model for how plate motion explains these surface features. While the teacher checks in on their progress, she does not direct them and allows them to carry out their own conversation (all student names are pseudonyms), exemplifying the four norms.

FIGURE 1

Seismic Explorer showing earthquakes, their depth and magnitude.

FIGURE 2

Tectonic Explorer.



Expansion

This is a norm for expanding the number of ideas that the community has about the phenomenon. When developing explanations, more ideas are inherently better, as the more ideas you have the better chance that you have a productive or useful idea.

In the example, the students were looking at a map of the Earth that displayed GPS data of continental plate movement (see Figure 3). The module is directing the students to think about where Africa was 10 million years ago and to justify this claim with evidence. Steven begins by claiming Pangaea originated near South America due to the lack of motion indicated by the GPS data. James expands on this claim by bringing in new ideas including the relative motion of Australia and Asia. Together they are beginning to collect evidence to support their developing idea of where the plate originated.

FIGURE 3

GPS Data.

Openness

This is a norm for all ideas being open to critique and examination. What makes this norm unique from simply sharing an observation or answering a question is that with it comes the expectation that any idea is *open* for critique. We are looking for "wiggle" words to indicate that they may want their idea engaged with. They may say "I wonder if … ", "What about … ", "I was thinking …", or "Maybe …". For this example, the students are working with Seismic Explorer.

In the example, James is demonstrating openness by speculating why mountains are forming. The norms of the class allowed James the space and opportunity to share his idea by framing it as "I just think that maybe …". Subsequently, Steven was able to critique that idea by bringing in counter evidence. This demonstrates how one student's vulnerability can lead to another's willingness to critique the idea and not the person.

Empirical testability

This is a norm for framing ideas in ways that are can be tested by bringing evidence to bear on them. We may hear students ask one another "How do you know?" or "What evidence do you have for ________?" Or they may point to a map, data table, reading, or image with the purpose of referencing it as they explain.

In the example, the students had noticed a space in a cross section between the deep and intermediate earthquakes within the Andes (Figure 3). It is this space or "gap" they are thinking about as significant for explaining plate motion as they explored other mountain ranges. Wanting to test the significance of this "gap", the students begin exploring or seeking more observations to support this idea.

Mutual understanding

This is a norm that all ideas should be understood by all the students in class, so the ideas can be fairly evaluated by the community. Mutual understanding recognizes the necessary initial step for science to progress is that the participants must understand one another's ideas clearly. The focus is on students expressing their ideas in ways that their peers can understand, not in arguing for their idea. The language may be very direct such as "I understand what you are saying." It may be more subtle such as the language we see in the example in Table 2.

In the final example, while looking at the image found in Figure 2, James and Steven discussed the motion of the plates represented by GPS data. James initially identifies one example that does not fit in with the rest: South America. Steven acknowledges this observation with his interpretation of the lines showing no motion. Steven shows mutual understanding not by agreeing, but by showing James he follows his thought and supports the line of thinking with evidence.

Conclusion

The *NGSS* emphasize a move away from memorization toward engaging in scientific practices. Foundational to those practices is the ability to communicate scientifically. For our purposes, we see progressive discourse as defining what it means to talk scientifically and therefore engage in scientific practices. Discourse-based teaching practices help students to engage with data, make sense of that data, and then use data to explain a phenomenon. Additionally, this kind of responsive teaching with a focus on supporting student talk has the potential to provide opportunities for traditionally marginalized student (e.g., students of color or special education students) with access to science (Brown 2021). The talk moves associated with responsive practices are often used in functional ways, meaning they are used with the goal of only advancing individual students' thinking with activities in the moment. While this is critically important, ultimately we want to create a classroom community where students engage with each other in an authentically scientific way. To do that requires thinking beyond individuals and focusing on establishing norms: expressing ideas in ways everyone can understand, expanding the number of ideas, opening those ideas to critique, and seeking data to support their ideas.

Functional and purposeful student talk

Often as teachers circulate, they are listening for "on task" talk or, more traditionally, silent attention to keep students engaged. In many cases when we say "on task," we mean talk that indicates the students are working on the activity by reading and answering the questions or talking through ideas as a means of answering the curriculum questions. The students from our example had moments where they did this. One student read the question and often typed in their answer while stating their ideas out loud and the other student either offered a change to the answer or affirmed his choices. All things considered, this can be seen as a success. The students were engaged and working together to try to answer the questions and complete the assignment. However, we want to move students beyond just being on task and answering questions they are asked, engaging in the *NGSS* practices, such as asking questions, constructing explanations, or engaging in argument, and make meaningful sense of the activities. To do this requires changes in the patterns of students' participation in classroom talk with each other and their teacher.

Being able to recognize progressive discourse can also allow teachers to formatively assess student progress toward the goals of the Common Core State Standards (*CCSS*). This may include listening for students comparing or contrasting sources of evidence, assessing sources of information, challenging the quality and relevance of data, or reasoning with data, for example. Awareness of student thinking related to the goals of standards can support early intervention strategies that may include utilizing talk moves in a more purposeful way.

As mentioned earlier, if a goal for science students is to engage in scientific practices described in the *NGSS*, then we see the four norms of progressive discourse as a way to support classroom scientific discourse and support this engagement; however, it is important to remember the norms of progressive discourse do not operate completely independently. They overlap or intertwine, so that more than one norm may be present in any example of student talk. What is important to note is that these are *norms*. They are shared ways of talking, not stand-alone statements, and help students to engage in authentic talk in a science classroom. Thus, they require support, practice facilitated by purposeful questioning, and time to establish.

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ONLINE CONNECTIONS

Table 2. Progressive discourse commitments with student examples: *https://bit.ly/3ST7fIT*

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