A framework for facilitating equitable discourse in science classrooms

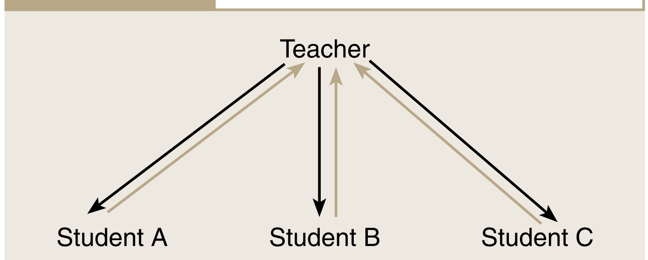
by Ellen Schiller and Jann Joseph

Middle school students love to get hands on and messy with science investigations. But when the investigation is completed and it's time to share findings, analyze results, and connect the experience to conceptual understanding, many students withdraw and are reluctant to participate in classroom discussions. Others—think Hermione Granger from the Harry Potter series—may try to dominate the discussion. From our experience as classroom teachers, professional development leaders, and professors of science teaching methods courses, we've developed a framework for facilitating meaningful, equitable classroom dialogue. This framework will help you create a risk-free classroom environment where inquiry-based learning can flourish.

The goals of group discussions should be to engage students in the concepts being studied and facilitate the expression of students' emerging ideas. Ideally, these discussions will also increase the teacher's awareness of students' current depth of conceptual understanding.

Students need time and opportunities to bounce ideas off each other as they work to make sense of investigations and research they've conducted, just as professional scientists do (Kelly 2007). We've observed many preservice teachers who think they're doing a great job of asking stimulating questions, calling on a variety of students, and encouraging student thinking. However, in post-lesson debriefings, these teachers are often surprised to hear that they're behaving in more traditional ways. They often call on the same few students—usually the first ones to raise a hand, who can be relied on to provide a "correct" answer and keep the discussion moving. Their questions tend to be of the convergent, "guess what I'm thinking" variety,

FIGURE 1 Representation of traditional classroom discourse



where students attempt to correctly answer a fact-based question instead of sharing their own insights.

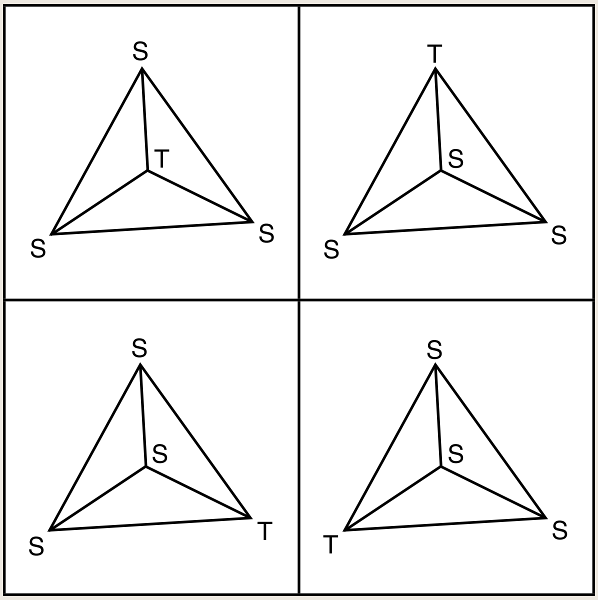
An inquiry-based classroom must be a risk-free environment where students feel comfortable sharing ideas, even those that might seem far fetched. To facilitate understanding, you have to know what your students really think about a concept, not what they think you want to hear. Middle school students are subject to peer pressure. They may be reluctant to tell you that they don't understand, much less let their classmates know that they're struggling with a concept. In our experience, students can be encouraged to open up, but this takes time and a plan.

Two frameworks for classroom discourse

In traditional classroom discourse, the teacher controls the discussion, asking most of the questions and calling on students to respond. Students' responses are usually directed back to the teacher. There may be interaction among students, especially during small-group investigation work, but the teacher remains at the pinnacle as the classroom leader during discussions. This is illustrated in Figure 1, where the arrows represent the dialogue between the teacher and students. This model does not work well for the inquiry-based science classroom, which depends on engagement, peer interaction, and student ownership of learning. A better model is needed, one that helps students share ideas and observations and engage in the work of science.

Our alternative framework for classroom discourse is the tetrahedron, which consists of four equilateral triangles (Figure 2). This framework suggests that the teacher and students are working together for a common purpose of shared learning. The tetrahedron's many edges illustrate the many possible avenues for interaction between classroom stakeholders. As you rotate the tetrahedron, *students* become the ones who question or initiate, and their peers assume the role of providing answers, responses, or commentary. Ask yourself, How often am I at the pinnacle in classroom discussions? How often is student A? What is group B's contribution? Is one student, or perhaps one cooperative group, dominant in the discourse? If students share time at the pinnacle, their conceptual, cultural, and individual views become part of the conversation. When students or student groups lead the classroom

FIGURE 2 Alternative to traditional classroom discourse



The tetrahedron is a framework to help inquiry-minded science teachers assess how well their classroom discussions are responding to the emphases of the National Science Education Standards (NRC 1996). It can help you:

- respond to individual students' interests, strengths, experiences, and needs,
- focus on student understanding of the use of scientific knowledge, ideas, and inquiry processes,
- guide students in active and extended scientific inquiry,
- provide opportunities for scientific discussion and debate among students,
- share responsibility for learning with students, and
- support a classroom community with cooperation, shared responsibility, and respect.

and their voices are validated, the discourse becomes richer and deeper learning occurs.

The tetrahedron model in practice

Facilitating equitable classroom discussions is a tricky business, one that requires thought and planning. Think of the possibilities suggested by the edges of the tetrahedron, and create a risk-free environment that opens the pathways of dialogue among all classroom participants. The edges of the tetrahedron represent the dialogue pathways between all classroom stakeholders: student to student, group to group, student to teacher, teacher to student, and student to group. The remainder of this article focuses on practical suggestions for putting the tetrahedron model into practice in your classroom.

Teachers as leaders of learning

The teacher is the classroom leader who sets the tone and facilitates learning in the classroom environment. Let students know that your classroom is a place of respect. Always model respectful treatment of students, and let students know that you expect the same of them.

Be sure students know that you are there to help them learn, that you're on their side, and that you'll do everything possible to help them grow as individuals. With this philosophy in mind, it's time to take a hard look at some common classroom practices that may be counterproductive. For example, we should steer away from calling on unprepared students, whether it's through random drawing of students' names, or through the old "gotcha" technique of questioning a student who appears to be daydreaming or off task. Both situations put students on the spot and create discomfort; there are more effective classroom management techniques for engaging students. We also discourage pop quizzes, because they tend to reinforce a view of the teacher as an authoritarian enemy whose role is to catch students unprepared. Teachers should not use assessments that may have unintended consequences, cause anxiety, or weaken the teacher-student bond of trust (Green and Johnson 2009).

Instead, focus on student-friendly practices. Ask open-ended questions and give students time to think before you call on someone. If you wait seven seconds before selecting a student, you will notice more hands going up (Blosser 1991). You will have the opportunity to call on a wider variety of students, and these students will become increasingly open to participating in classroom discussions.

We've all had experiences where no one raises a hand, and this is the time to dig deeper into your bag of tricks. While speaking to the whole class may be intimidating for some students, talking with a partner or in a small group is less threatening. Incorporate more "think-pair-share" moments in which students gather their thoughts and discuss them with a neighbor before you ask for some pairs to share with the larger group.

Even in an inquiry-based science classroom, shy and marginalized students can blend into the woodwork without a concerted, yet subtle, intervention on your part. Look for body language, which often speaks volumes. If a student is sitting quietly, but has a thoughtful look or is making eye contact with you, this is the perfect time to speak directly to the student and say something like, "It looks like you're really thinking about this, Tasha. Is there something you want to share or ask?" In our experience, the student often has something to say, but is more introverted and needs a little encouragement. If a student does not have something to share, just move on to a another student or group. Get to know your students as the year goes on and you will learn how to help students open up. We suggest students keep journals, either in notebooks or online, and submit exit tickets regularly. (Exit cards or tickets are a quick assessment tool for teachers to help them become more aware of student understanding of concepts taught. Exit cards are written student responses to questions posed at the end of a class or learning activity or at the end of a day. They may be used at any grade level and every subject area.)

The journal and tickets can be used as a springboard for classroom sharing. For example, a student with an interesting observation can be asked to share that insight with the class.

Deep knowledge of content can help a teacher formulate good open-ended questions. When teachers are not as familiar with the content, Carlsen (1997) found that they tend to ask more questions but that the questions tended to be superficial and fact based. So, for each lesson, prepare some thought-provoking questions that will help guide student engagement and thinking. Generic, open-ended questions should also be a standard part of your repertoire: "Can you share a little more about what you're thinking?" "Why do you think so?" "What do others think about that idea?" These are always good for encouraging deeper thinking and more sharing from a student. Closed questions that elicit yes/no responses, or brief, factual responses, do little to encourage open classroom dialogue. They also don't deepen student engagement or tell you much about students' conceptual understanding.

Students as leaders of learning

The tetrahedron model is also helpful when thinking about peer groupings because it facilitates equity in student-to-student interactive dialogue. Small groups are often the primary organizing structure for hands-on inquiry investigations. These groups might be primarily motivated by a shortage of materials, but it's also the perfect opportunity for encouraging cooperative learning and peer discussion. Teachers often look for ways to make these groups more equitable and productive. But simply asking students to form and work in cooperative groups is not the answer.

Just as participation in classroom discussions can be inequitable, we've all seen students who either take over or are excluded from small-group work. Research has shown that students can systematically deny peers access to materials and limit their participation, even in cooperative groups (Bianchini 1997, 1999). However, assigning groups and then assigning leadership roles within the groups helps to engage all the group members in substantive ways. Students can also self-select the roles and take turns with each role. We have found that they have very good memories and will keep track of who's had turns doing each role. Typical roles might be a materials getter/messenger, a recorder, a reporter, and an on-task supervisor, who monitors the group as it works. See Schiller, Joseph, and Konecki (2004) and Frey, Fisher, and Everlove (2009) for additional suggestions on managing group roles in science classrooms.

Like scientists, students need to report on their inquiry investigations. Take time to give students the opportunity to reflect on their learning and to self-assess. Young people need to own their new knowledge and skills, and what they've learned through the process. Sharing can happen informally, in postinvestigation discussions, and formally, through their choice of preparing a poster or sharing a short presentation. When students prepare posters as a group or as individuals, it is possible to use a half-and-half process, with half of the class serving as "docents," telling about their investigations, as the other half of the class circulates and learns what their peers found out. This may be a less intimidating way for students to begin presenting their findings to the class.

Once students have become comfortable with the "share-a-thon" format, you can begin to have groups and individuals present to the whole group. Just as scientific researchers share their work at conferences with their peers, students can learn to share and defend their findings, and to respectfully respond to others' work. If you've created a safe classroom environment where students feel comfortable taking risks, rich classroom discourse can occur. Students thus take turns at the pinnacle of the tetrahedron, leading peers through an examination of their findings and conclusions; their peers and the teacher learn from their work. This process can generate further questions for inquiry exploration or research.

The value of the unexpected

Students have a natural curiosity about the world that is frequently expressed when they're young. But it tends to diminish as students learn how to "do school" and conform to the school's curriculum and routine. You have probably noticed that a four-year-old's "Why?" seems to transform into a fourteen-year-old's "Do I need to know this for the test?" Helping that curiosity reemerge is one of the goals of any inquiry-minded science teacher.

One of us taught an ecosystems unit that involved making stacking soda-bottle terraria/aquaria columns. The biological supply company was temporarily out of the duckweed needed for the aquaria guppies' food source, so a teaching colleague went to a local stream to collect some. While the catalog-bought duckweed always arrived in pristine water, the stream water was filled with planaria and other microscopic life that students found 10 times more interesting than the duckweed itself. This "teachable moment" developed into a full-fledged inquiry excursion into species identification, planaria regeneration, and other *student-generated* questions. In a standards-driven era, we need to make time for these types of learning experiences and the rich discourse that accompanies them. The excitement that is kindled is critical to helping students realize what the work of scientists entails.

With the pressure of standards-based curricula and standardized testing, many teachers are telling us that they don't have as much time for inquiry-based science teaching. Even though they know that it's the way to go, they worry that open-ended discussions will take longer and hamper their progress through the year's material. We encourage teachers to look beyond the content and realize that developing scientific habits of mind in students is as important as understanding content. Science learning needs to be engaging, interactive, and fun so that students see the concepts as accessible and science as a subject they'd like to pursue further. ■

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