RESEARCH ON LEARNING

Getting Students Talking: Supporting Classroom Discussion Practices in Inquiry-Based Science in Real-Time Teaching

NONYE ALOZIE, CLAIRE MITCHELL

Abstract

Why is it so hard to get students talking in science class? Who is responsible? Are the students unwilling to speak in class? What kinds of supports are helpful for in-the-moment teaching during classroom discussions in science? We present one high school teacher's facilitation of science discussions while supported by a dialogic discussion structure that was collaboratively developed through professional-development workshops. Our findings provide a real-time teaching tool for teachers working toward integrating inquiry-based science discussions in their classrooms.

Key Words: *Dialogic discussion support; IRE recitation; inquiry-based; scientific communication.*

○ Scientific Communication in the Classroom is Important but Difficult

Scientific learning environments that advocate the use of inquiry-based skills also promote teaching scientific communication by engaging students in classroom discussions. Such inquiry-based approaches are premised on enculturating students into the scientific community (Lemke, 1990; Kelly & Green, 1998; Crawford et al., 2000; Magnusson et al., 2004). Students learn to find solutions to real problems by asking questions, designing and conducting investigations, gathering and analyzing data, making interpretations, drawing conclusions, and reporting findings (Krajcik et al., 1998).

Although oral exchange of ideas is a necessary inquiry skill, students continue to have difficulty determining how and when to use different types of classroom and scientific discourses (Moje et al., 2001). In the complex school setting, teachers are faced with an array of students with highly variable characteristics and unpredictable responses; therefore, they must process large amounts of information quickly. Teachers, then, are challenged with integrating "scientific talk" into the learning experiences of students. Because of time constraints and a lack of supports, teachers greatly abbreviate the potential depth that these discussions can provide.

Teachers, then, are challenged with integrating "scientific talk" into the learning experiences of students.

As a result, teachers and students may not have opportunities to participate in and contribute to the scientific discourse community. Instead, teachers and students engage in IRE (Initiate–Respond–Evaluate; Mehan, 1979; Tharp & Gallimore, 1991) recitation, in which teachers continue to bear the bulk of knowledge and students are recipients of knowledge. In IRE recitation exchanges, students generally respond with short or one-word answers as responses to recall questions (see Figure 1).

To help teachers guide students away from IRE recitation patterns, we collaborated with teachers to design discussion supports

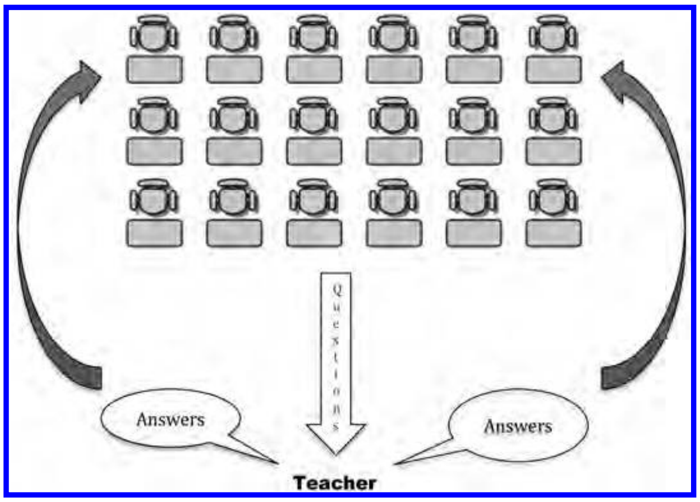

Figure 1. Typical classroom discourse pattern, in which students direct questions to the teacher and the teacher provides answers. This pattern is generally unidirectional and positions the teacher as the bearer of knowledge and the students as recipients of information.

The American Biology Teacher, Vol. 76, No. 8, pages 501–506. ISSN 0002-7685, electronic ISSN 1938-4211.
DOI: 10.1525/abt.2014.76.8.3

that could help direct scientific discussions. Some common types of classroom discussion are generating, problem-solving, and reviewing discussions (see Tables 1, 2, and 3). A combination of these discussion structures can help teachers and students interact in more scientific ways because they involve students building shared understandings of ideas and of the nature of the discipline as they engage in discourse with their classmates.

Here, we provide a tool that can help support teachers in real-time teaching – a tool that can be an "immediate-use strategy" for teachers. The goal of this tool is to help teachers facilitate a free exchange of ideas in which students challenge each other, provide evidence with their responses, give each other feedback, and ask follow-up questions. To demonstrate its use, we present background of the design process and an example of one high school science teacher using the tool.

○ Background of Project

This descriptive case study emerged from a larger project, "How Similar and Different Are We from Each Other?" (National Institutes of Health: PAR05-068), that integrated an inquiry-based genetics and genomics curriculum into 13 high school biology classrooms in the Midwest (Alozie et al., 2010a). To support the teachers in implementing the integration of this curriculum, two professional-development workshops were offered. These workshops were developed to support the use of the curriculum materials designed around national benchmarks and standards (AAAS, 1993).

During the enactment of this curriculum, we found that these curriculum materials did not effectively support the teachers in integrating inquiry-based discussions in their lessons (Alozie et al., 2010b). As a result, a smaller study emerged that sought to examine

Table 1. Generating discussion.

Concept	Strategies	Rationale
Make a Public Document	Use a chart on the chalkboard, overhead, or dry-erase board. Use student drawings. Have a student lead the discussion by creating a chart on the board. Have each student write their individual ideas on the board.	Keeping track of student responses with a public document encourages listening and reflection.
Think/Pair/Share	Provide students with the questions that you will use in the larger discussion as guidelines for their small-group discussion.	Helps the individual student before they have to talk in a group. Students practice on a partner/in a group before addressing the class.
Prereading/Activity Brainstorming	*Connect this to the public document made:* Why are we doing this? What do you think is going to happen when…? What do you think it means to…? Do you know anyone that…?	Helps the students start to think about what they will be learning and helps them access their prior knowledge and understanding of a topic. Relates the activity/reading to the student.
Follow-up Questions	What have you observed or experienced? What else is on your group's list? What do you/other people think about when they hear the word _______________? Who has a different idea/response/way of thinking about this? What do you know about [topic X]?	Follow-up questions help push the students' understanding; they are meant to help them consider deeply why they think they know something. Such questions connect to the public document and the driving question.
Student Interactions	It is important for students to learn how to communicate in science (vocabulary and behaviors).	*Student-centered:* Encourage STUDENT discussion and initiation of questions and follow-up questions. Try to GUIDE the discussion rather than lead it. *Addressing other students:* Encourage students to address each other and ask each other questions. Ask students to consider a previous response while formulating their own.

Table 2. Problem-solving discussions.

Concept	Strategies	Rationale
Make a Public Document	Use a chart on the chalkboard, overhead, or dry-erase board. Use student drawings. Have a student lead the discussion by creating a chart on the board. Have each student write their individual ideas on the board.	Keeping track of student responses with a public document encourages listening and reflection.
Use of Evidence	What evidence do students use to explain their answers? What do we know so far? What do we want to formulate from what we know? Predictions: What would happen if ________________ changed?	Helps students make their knowledge known to the class and themselves (can use the activity, the readings, or other resources).
Follow-up Questions	How does X compare with Y? How can/does this relate to the question driving the lesson/unit? How do you know? What evidence supports this idea? What does it mean to say______________________? Why doesn't our old model work to explain this new phenomenon? How does this fit into the whole picture of what we have learned? What new questions do you have?	Follow-up questions help push the students' understanding; they are meant to help them consider deeply why they think they know something. Such questions connect to the public document and the driving question.

what specific tools could best support teachers in engaging students in scientific discussions. Three teachers agreed to attend four additional professional-development sessions about facilitating classroom discussions and worked to design three dialogic discussion supports (DDS) (see Tables 1, 2, and 3).

○ Case Study: Ms. Ina

We will focus on one participant's experience in creating and integrating the DDS while attending the professional-development workshops, highlighting how this teacher used the DDS as a guide for in-the-moment strategies as she worked to move her students toward inquiry-based science discussions. To maintain confidentiality, we chose a fictitious name, Ms. Ina, for this participant. Ms. Ina is a Latina teacher, teaching in a predominantly African-American school, composed of 99% African-American students. She enacted the materials in two 10th-grade general biology classes. At the time that the unit was enacted, Ms. Ina had been teaching for 5 years.

○ Preparing to Integrate Inquiry-Based Discussions

When Ms. Ina started attending the professional-development workshops, she quickly claimed that inquiry-based science was difficult to teach. Because the term *inquiry* can take on various meanings (Levy et al., 2013), it was important to come to a consensus on what it meant in their process of enactment. For the sake of sharing a common definition of inquiry, we decided that we would use inquiry as a means: "[S]cience educators exploit inquiry as a pedagogical approach that helps students develop understandings of science cross-cutting concepts and ideas" (Levy et al., 2013, p. 390). Ms. Ina, like the other teachers, asked for a "plan of action" in order to be successful during instruction. She wanted to know how inquiry could come to life in the classroom.

Although Ms. Ina knew that additional supports would help her have more engaging discussions, she realized that she struggled to understand her students and their way of speaking. Ms. Ina recognized that something additional needed to be done and that employing a strategy was not enough. She recognized that because inquiry-based instruction requires a change in classroom culture, teachers must make time for pushback from students. Teachers have to be aware of how students might respond to such changes in traditional forms of schooling, and continue to encourage and insist that students participate in inquiry-based discursive practices. With these considerations in mind and through collaborative efforts, the DDS were developed. These supports helped Ms. Ina move forward with her implementation plan of action (see Table 4).

Table 3. Reviewing discussion.

Concept	Strategy	Rationale
Supporting Communication	Use a chart on the chalkboard, overhead, or dry-erase board. Use student drawings. Have a student lead the discussion by creating a chart on the board. Have each student write their individual ideas on the board.	Keeping track of student responses with a public document encourages listening and reflection.
Follow-up Questions	How does X compare with Y? How can/does this relate to the question driving the lesson/unit? How do you know? What evidence supports this idea? What does it mean to say_______________? Why doesn't our old model work to explain this new phenomenon? How does this fit into the whole picture of what we have learned? What new questions do you have?	Follow-up questions help push the students' understanding; they are meant to help them consider deeply why they think they know something. Such questions connect to the public document and the driving question.
Student Interactions	*Student-centered:* Encourage STUDENT discussion and initiation of questions and follow-up questions. Try to GUIDE the discussion rather than lead the discussion. *Addressing other students:* Encourage students to address each other and ask each other questions. Ask students to consider a previous response while formulating their own.	It is important for students to learn how to communicate in science (vocabulary and behaviors).

Table 4. The enactment process.

Stage of Enactment	Problem	Solution
Understanding Inquiry	Inquiry is hard; I need a plan of action.	Come to a consensus on the meaning of inquiry before instruction.
Understanding Students	Cultural mismatch between student and teacher.	Teachers must make time for pushback from students and persevere through the discomfort.
Physical Positioning in the Classroom	Teacher stands in front of the class.	Teacher moves to the back of the room or out of the students' line of sight.
Give Students Ownership	Students wait for the teacher to lead the discussion.	Support students in discussion initiation. Ask open-ended and explorative questions.
Guide the Discussion	Teacher leads the direction and progression of the discussion.	Provide follow-up and guiding questions to assist the students in sustaining the discussion.
Anticipate Student Frustration and/or Pushback	Students may begin to express frustration or become withdrawn.	Teachers must make time for pushback from students and persevere through the discomfort.
Summarize the Discussion	Teachers move on to new topics without checking for understanding.	Allow students to review content just discussed.

○ Using the Discussion Support While Teaching: Reviewing a Reading

When Ms. Ina was ready for enactment, she established goals and potential changes to instruction that aligned with the DDS (see the summary of enactment for Ms. Ina's use of the DDS in Table 4). Before the discussion began, Ms. Ina physically changed how she positioned herself in the classroom. Usually, Ms. Ina stood in front of the class at the blackboard. However, for the purpose of teaching students to be independent, she changed her location to the back of the room. She sat in a student desk behind the students in order to change the focus of the students. Although confused by this move, the students were forced to redirect their attention to each other.

Next, she asked a student to lead the discussion, forcing the students to take the role of knowledge-bearer (Magnusson et al., 2004). The nominated student moved to the front of the classroom and stood quietly, unclear of how to proceed. Ms. Ina supported this new discussion format by encouraging her to ask the class a question about a reading on lactose intolerance. It is important to note that before engaging the students in the discussion, Ms. Ina asked the students to do a Think/Pair/Share activity; thus, the students had to first think about a response on their own, then share their response with a neighbor, and finally share the response as a group. This particular discussion began the "share" portion of the Think/Pair/Share activity.

Ms. Ina decided to use a reviewing discussion to help the students understand the reading about lactose intolerance. She began the conversation by asking a "Why" question: "Why is Jason lactose intolerant?" The "Why" indicated that she wanted the students to explore answers to the question, providing evidence and reasoning with their answers. Following her question, she instructed the student to lead the discussion by calling on other students. As suggested in the "Student Interactions" portion of the DDS (refer to Table 3), Ms. Ina shifted the responsibility of sustaining the discussion to the students, leaving members of the class to work together to answer the question. Consistent with the "Supporting Communication" section of the DDS, the student discussion leader created a public document on the blackboard (see Table 3), a record of contributions made by the students in the classroom. Creating a public document is suggested as an effective discussion strategy because it can serve as a collective memory for the class and can provide additional ideas that otherwise might not have been said (Magnusson et al., 2004).

As the discussion progressed, Ms. Ina worked to guide the discussion rather than lead it, as suggested by the "Student Interactions" section of the DDS. She pushed the discussion forward by following up student responses with comments like "But we are answering *why* he can't." With these guiding statements (see Table 3), Ms. Ina encouraged the students to provide evidence-based answers, rather than simply defining lactose intolerance (recall information). Students learned to contribute to the discussion with explanations and reasons, rather than one-word responses.

As Ms. Ina predicted, some students exhibited frustration with the deviation from the traditional IRE recitation. For example, one student expressed annoyance and defeat when another challenged him. Ms. Ina encouraged him to clarify his responses and for other students to assist him, in an attempt to promote communication among the students (see "Follow-Up Questions" and "Student Interactions" in Table 3). At the end of the discussion, Ms. Ina worked with the student discussion leader to summarize the ideas written on the board. This action not only validated the students' contributions but also helped them synthesize information that emerged from the discussion.

Ms. Ina committed to encouraging a culture of scientific discourse in her classroom. The use of the DDS was helpful in her enactment. She used the suggested strategies and, most importantly, committed to their use throughout the duration of the discussion. From these practices, the students started to make changes in their participation. They worked together, supported, assisted, and challenged each other's ideas.

○ Limitations & Implications

Our findings should be considered with several important limitations in mind. First, this paper presents one teacher's enactment, which may limit the transferability of the findings. To mitigate this limitation, all attempts were made to have in-depth interviews with Ms. Ina, as a way to understand her thinking and enactment process. Another limitation concerns selection bias: Ms. Ina self-selected to take additional professional-development workshops, showing a predisposed interest in this topic. Ms. Ina may have been more motivated to alter her teaching practices, which could have implications for the findings.

Despite these limitations, our findings build on previous studies of communication in scientific inquiry-based learning. Although the scientific community advocates the use of scientific discourse in the classroom, its implementation proves hard to achieve. Getting students to "talk science" requires deliberate organizational and cultural structures in the classroom. As shown in the present study, students can learn to use the conventions of scientific discourse, if the teacher is supported with ongoing and in-the-moment enactment tools. Expect time and care to be taken in order to experience instructional changes and increased student autonomy and participation. Over time, students can begin to "talk science."

References

AAAS. (1993). *Benchmarks for Science Literacy.* New York, NY: Oxford University Press.

Alozie, N., Eklund, J., Rogat, A. & Krajcik, J. (2010). Teaching modern genetics through project-based science. *American Biology Teacher, 72,* 225–230.

Alozie, N.M., Moje, E.B. & Krajcik, J.S. (2010). Supporting teachers in the practice of discourse in project-based learning environments. *Science Education, 94,* 395–427.

Crawford, T., Kelly, G.J. & Brown, C. (2000). Ways of knowing beyond facts and laws of science: an ethnographic investigation of student engagement in scientific practices. *Journal of Research in Science Teaching, 37,* 237–258.

Kelly, G. & Green, J. (1998). The social nature of knowing: toward a sociocultural perspective on conceptual change and knowledge construction. In B. Guzzetti & C. Hynd (Eds.), *Perspectives on Conceptual Change: Multiple Ways to Understand Knowing and Learning in a Complex World.* London, UK: Routledge.

Krajcik, J., Blumenfeld, P.C., Marx, R.W., Bass, K.M., Fredricks, J. & Soloway, E. (1998). Inquiry in project-based science classrooms: attempts by middle school students. *Journal of the Learning Sciences, 7,* 313–350.

Lemke, J.L. (1990). *Talking Science: Language, Learning, and Values.* Norwood, NJ: Ablex.

Levy, B.L.M., Thomas, E.E., Drago, K. & Rex, L.A. (2013). Examining studies of inquiry-based learning in three fields of education: sparking generative conversation. *Journal of Teacher Education, 64,* 387–408.

Magnusson, S., Palincsar, A.S. & Templin, M. (2004). Community, culture, and conversation in inquiry-based science instruction. In L.B. Flick & N.G. Lederman (Eds.), *Scientific Inquiry and Nature of Science* (pp. 131–155). Dordrecht, The Netherlands: Kluwer Academic.

Mehan, H. (1979). *Learning Lessons: Social Organization in the Classroom.* Cambridge, MA: Harvard University Press.

Moje, E.B., Collazo, T., Carrillo, R. & Marx, R.W. (2001). "Maestro, what is 'quality'?": language, literacy, and discourse in project-based science. *Journal of Research in Science Teaching, 38,* 469–498.

Tharp, R. & Gallimore, R. (1991). *The Instructional Conversation: Teaching and Learning in Social Activity.* Santa Cruz, CA: National Center for Research on Cultural Diversity and Second Language Learning.

NONYE ALOZIE (nalozie@albion.edu) is a Professor in Math and Science Education and CLAIRE MITCHELL (cmitchell@albion.edu) is a Professor in Social Studies Education, both at Albion College, 611 East Porter St., Albion, MI 49224.