A Web of Ideas

Fostering scientific discourse with spider web discussions

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As a science teacher you have probably planned for a rich discussion in your class only to be met with blank stares from your students. Maybe you have avoided peer-to-peer discussion due to limited class time. These concerns keep many teachers from working toward rich discourse in their classrooms (Roth and Garnier 2006). This is problematic if we accept the notion that talking is thinking (Cazden 2001).

There is substantial evidence to suggest that social interactions, and discourse in particular, are the strongest drivers of learning (National Academies 2018), suggesting that we need to promote productive talk in our classrooms (NRC 2012). While the Next Generation Science Standards practice of "obtaining, evaluating, and communicating information" has an explicit connection to scientific discourse, "engaging in argument from evidence" and arguably all NGSS practices are facilitated through discourse in the real world. We need to teach students how to have a productive conversation so they can fully engage in the scientific process. Leading productive discourse can be learned and when facilitated well, leads to greater equity of voice in the classroom (Windschitl, Thompson, and Braaten 2018).

In our own search for scaffolds to help students learn how to have productive discussions, we encountered Spider Web Discussions (SWDs), an instructional routine that structures classroom talk and allows the teacher to monitor the content and process of the discussion (see “On the web”). We have found SWDs to be a powerful tool that allows students to reflect on their content knowledge and wrestle with socio-scientific issues facing us. Students are also excited about the gamification of the process and regularly ask for SWDs.

How to run it and what it looks like
In an SWD students have a meaningful conversation about an important topic. The teacher graphs the flow of the talk to assess the quality and equity of the discourse, as well as the quality of the content that students present. Ideally, students are seated in a circle (Figure 1), and as each student participates in the conversation, the teacher draws a line from one speaker to the next on a diagram of the students’ seats, creating what looks like a spider web (Figure 2, p. 50). The teacher also makes notations on the web about the quality of the talk.

We have found that displaying the developing web on a projector in real time can improve the process by giving students ongoing feedback of who needs to be brought into the conversation and who should yield the floor to peers. With repeated use, discourse skills become automatic for students, giving them tools for productive talk outside of the SWD format. At the conclusion of the conversation the students self-assess the web and discuss what they could improve on the next time. We have found that our students are invested in making better webs, so the quality of the conversations improves over time.

Preparing for a Spider Web Discussion
The success of SWDs hinges on the teacher’s preparation for the activity. The teacher must select an important idea for students to discuss (for examples, see Figure 3, p. 52) and make sure students are adequately prepared. This may mean providing prompts and research time ahead of the discussion or recognizing that other class activities have prepared students for the discussion. Students are most successful and more comfort-
able sharing ideas when they have organized, written notes and ideas in front of them during the discussion. SWDs can be used to present a problem that must be solved, to collectively design an investigation, to discuss data, as a scientific argumentation session, or for any other purpose that is open to multiple voices and multiple interpretations. SWDs are not well suited for establishing a singular idea or landing on a set of facts.

Before the discussion, help students prepare by framing the purpose: to elicit students’ ideas, support ongoing changes in student thinking, or draw together evidence-based explanations (Windschitl, Thompson, and Braaten 2018). While it may seem natural to use SWDs as a culminating activity for a unit, we have found them to be powerful tools throughout a unit and particularly when students are expressing their initial ideas about a phenomenon.
During the discussion
Handing control of the discussion to students can feel uncomfortable at first, and there may be some awkward starts and stops. We find, however, that the feedback of the spider web keeps students on track and allows us to monitor what is being shared rather than focusing on the next thing the teacher needs to say. At times we will assign specific roles for students (Figure 4, p. 53). In an ideal discussion, the teacher is silent, making notes on the spider web as the conversation proceeds and only intervening when the discussion seems to be getting off track.

We try to keep the notation simple to provide instant feedback to the students on the quality and the content of the discussion. In the science classroom we use the notations to reward contributions that bring in relevant data or background knowledge, use evidence to support a position, invite a peer into the conversation, ask a peer to support his or her position with evidence, and synthesize the ideas of multiple students (Table 1). The notations also allow students to see the difference between contributions that move the discussion forward and tangents. In a large class, it can be helpful to use concentric circles or split the class into smaller groups with assigned student recorders.

### TABLE 1

<table>
<thead>
<tr>
<th>Notation</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>Using EVIDENCE to support a claim or to adapt a conceptual model</td>
</tr>
<tr>
<td>*</td>
<td>Bringing in a direct QUOTE or data from a resource</td>
</tr>
<tr>
<td>*</td>
<td>Insightful comment</td>
</tr>
<tr>
<td>V</td>
<td>INVITING a peer into the conversation</td>
</tr>
<tr>
<td>C</td>
<td>Asking a peer for CLARIFICATION about their statement/claim.</td>
</tr>
<tr>
<td>CH</td>
<td>Respectfully CHALLENGING an idea or data that have been presented</td>
</tr>
<tr>
<td>S</td>
<td>SYNTHESIZING the ideas of multiple other students</td>
</tr>
<tr>
<td>I</td>
<td>INTERRUPTION</td>
</tr>
<tr>
<td>D</td>
<td>DISTRACTED or off-task talk</td>
</tr>
</tbody>
</table>

The primary purpose of these codes is to provide feedback to students about the use of the discourse moves you value as their teacher. Use just a few to start and then add more as needed.

The teacher’s role in SWDs evolves over time. As the expert in the room, the teacher has an important voice in the conversation but not the only voice. It is best for the teacher to not speak during the discussions at first, unless there is a threat to an emotionally safe learning environment or the discussion moves off course.
for an extended period. After the class gets used to the format, the teacher can join the conversation as another participant, not the conversation leader. You and the students will quickly notice on the web if you are talking too much! It is powerful for your students to see you modeling scientific reasoning as well as the norms for productive discourse when you defer to other speakers and weave yourself into the conversation rather than running it.

**Attending to equity**

Scaffolding discourse skills is a strong approach to increasing equity for your students. Effective communication skills affect almost every aspect of students’ future academic and professional lives. However, equity is not automatic in discussions. The first step for supporting equity during classroom discussion is to make sure that everyone has thoughts, ideas, and information to contribute to the conversation.

Use your knowledge of your students to differentiate accordingly. Some students may be able to run with a simple research prompt while others will benefit from additional supports, down to the level of sentence frames they can use. By making sure that each student has something productive to share, you decrease the risk that they will be excluded from the conversation. English language learners (ELLs) benefit from vocabulary lists, science notebooks, prepared notecards, and “pregame” sessions where they can practice sharing ideas. It can be useful to pair ELLs with another student with whom they can rehearse potential discussion exchanges.

As with any classroom discourse, a safe space must be created for sharing ideas. Students should be introduced to an initial set of norms for productive discourse that will support equity of voice during the discussion. Keep the list simple, memorable, and posted as a public record. More importantly, revisit the list regularly and give students the opportunity to propose changes to the norms as the class learns to work and talk together. Setting all students and the group up for success is the goal. Assigned seat-

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**FIGURE 3**

**Examples of high-leverage spider web discussion prompts.**

**Specific**

1. Is our societal investment in radio, infrared, or cellular technology worth any potential risk?
2. Which physical property of matter impacts us the most in our daily lives?
3. Should our town use NaCl, MgCl₂, or sand to deal with icy roads?
4. Considering these three models, what would we expect the climate to be in 50 years?
5. Should human cloning be allowed?
6. Should scientists be political advocates?
7. Is it our responsibility to address climate change?
8. Where would you put your funding, nuclear fission, or fusion research?
9. What are solutions for overcoming the energy crisis? Water crisis?

**General**

1. How can we most effectively investigate our hypotheses?
2. Considering the data from all of the physical science classes, which model is the best explanation of the phenomenon?
3. Should we trust these data we collected?
4. Which claim has the strongest evidence and reasoning to support it?
5. What purpose does our current model serve and how can we adjust it or include additional models to reach our ultimate goal?
6. Based on our existing model, what would we expect for the outcome of our experiment?
7. What are the strengths and weaknesses of these competing theories?
8. What plausible hypotheses could explain this phenomenon?
9. What is the unknown substance?
Figure 4

**Student roles* that can be assigned for the discussions.**

**Tracker:** A student can be the person that draws the spider web as you go. This is mandatory if you have multiple discussions going on at the same time. This is a good role for a student who has been absent or who is otherwise unprepared to participate.

**Host:** This student can initiate the conversation and takes a primary role in inviting others into the conversation or asking talkative peers to yield the floor to other voices. This is an important and difficult role that requires both the skills to manage the discussion and the social awareness to know when to bring quiet peers into the mix.

**Skeptic:** This student can act as the person who helps participants question their assumptions and critically examine information. This is also a difficult role, requiring a student who can be productively skeptical without being cynical or discouraging contributions. Only add this role if students are accustomed to the format and need a little help questioning the assumptions being made.

**Key Question Ask er:** This student is only allowed to ask two to three important questions during the discussion. This is a good role for a student who is overly dominant in conversations. The role requires reflection on what makes a strong contribution to a discussion.

**CER Evaluator:** In the heat of the discussion, scientific argumentation can easily miss a key component (*claim, evidence, reasoning*). This student can monitor these components specifically and ask contributors to add them as needed.

**Assessor:** This student often does not participate directly in the discussion. They keep a record of productive or distracting turns in the conversation and track progress on the group rubric. They report at the end of the discussion and may jump into the conversation to encourage some element of discourse that the group has not attended to well.

*Be judicious with the use of student roles. Often, they are not needed at all. Use them to support students who need extra help or guidance in the discussions, to highlight key skills, or to move toward equity.*

Assessment

While SWDs are powerful tools for supporting student thinking and discourse skills, we have also come to appreciate their effectiveness as assessment tools. Following an SWD, the teacher should have a sense of whole-class and individual students’ understanding of the subject, and can be responsive to the discussion results right away. The other side of formative assessment—the idea that students should be able to use it to directly improve understanding—is often forgotten about. SWDs facilitate that metacognition at the concluding reflection and also in real time as the conversation is captured in the web.

It is useful to stop the conversation midway to ask students how the web is forming and what could be done to improve it. After the discussion, it is imperative to give students time to evaluate the web. Ask students to identify particularly important moments in the conversation, in both discourse and in making sense of the science content. This can be started effectively in small groups, but students should be asked to have a final conclusion of their own in order to help the teacher identify students who might need targeted interventions on skills and content knowledge.

We recommend assigning group grades rather than individual grades for the SWDs. This simple change transforms the discussion from a competition to a shared sense-making endeavor. The students are incentivized to contribute and also to
FIGURE 5

Variations for using spider webs in the science classroom.

1. Use as an alternative or in addition to the poster sessions within the “Argument-Driven Inquiry” Model (See Victor Sampson’s ADI series in NSTA resources).

2. Use the discussion to transition from academic to applied content. By reframing the content knowledge in an authentic applied setting, students get much needed practice with transfer.

3. Split large classes into multiple groups. This requires students to record the web. Consider concentric circles if keeping one group.

4. Use Page Keeley’s formative assessment probes for discussion prompts as students grapple with best explanations for phenomena (See Keeley’s “Uncovering Student Ideas in Science” series in NSTA resources).

5. Allow students to prepare the discussions in small groups and encourage testing out ideas in those small groups.

6. Use the NGSS crosscutting concepts as discussion threads, particularly if the discussion is intended to transition from one unit to another.

7. Rather than selecting a topic when planning a unit, try waiting to see what ideas multiple students are intrigued by and use the discussion to amplify their engagement.

Conclusion

In Figure 5 we present some suggestions for science-specific uses of SWDs to accompany the generalized description above. Productive discourse is one of the most powerful tools in the science teacher’s toolbox, and building toward it can be relatively easy with the right scaffolds. We all tried introducing the practice in our very different classrooms with a healthy dose of skepticism. After using it regularly, we believe SWDs have much potential across a wide variety of contexts if teachers trust the process, take the time to prepare students, and give students the opportunity to improve over time.

ON THE WEB
Alexis Wiggins’ spider web discussion blog: http://alexiswiggins.pbworks.com/w/page/57830797/Alexis%20Wiggins%27s%20Wiki

REFERENCES


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