Developing Persuasive Voices in the Science Classroom

Argument can extend and support science explanations.

By Marlene Thier

As teachers, we know that real learning does not take place in an environment in which students are "seen but not heard." When we give our students a chance to express their ideas aloud, we give them the opportunity to make their ideas concrete through that expression. An idea that is unexpressed is a lost thought that cannot be commented on, considered, or negotiated. The act of articulating thought helps students better understand the information they are trying to assimilate. Informal discussions give students a venue to try out their ideas and listen to what other students are thinking and, based on what they heard, change and expand their own ideas or understandings.

A spontaneous exchange of ideas also enables students to practice using evidence to present and defend their points of view and helps them to learn to work collaboratively—an important skill for students to develop regardless of what is being taught. We discover and sharpen our own ideas by talking about them and seeing how other people react, a crucial element of learning that Harlen (2000) calls "negotiated meaning."

This article examines the role of argument in the science classroom and how it can be used to help students develop science process skills (e.g., using evidence to defend a point of view) and literacy process skills (e.g., using language precisely to express a particular point of view and extending these understandings through the use of notebooks). The classroom application shared here describes an inquiry experience with fourth- through sixth-grade students, but the concept of using evidence and language to defend a point of view is an idea that can be adapted to any elementary grade level.

Kinds of Speech

When we think about the role of science in our students' lives, we know that science will play an increasingly central role in their lives, now and after they leave school. As citizens, our students will be called on to make evidence-based judgments and express their views. Language is the framework within which tomorrow's science-based public issues will be structured and decided as various factions use language artfully to persuade others to their points of view. For this reason, we need to be sure that argumentation is a part of the dynamic elementary science classroom. By teaching students how to defend their points of view, this reinforces in our students the idea that science is happening now and can change based on evidence.

To look at how this could work practically in your classroom, it is important to consider the two general categories of speaking that students can use in the classroom. The first category of speaking is *exploratory speech,* which includes the spontaneous exchanges that take place among your students in work groups and between your students and you, their teacher. Students can use exploratory speech to experiment with ideas as they focus their thinking.

The second category of speaking is *presentational speech,* which students use to share their ideas with others

in a more prepared and formal way. Presentational speech requires a more structured set of rules to be able to do effectively. For example, when students try to persuade one another of their point of view, they are using a form of presentational speech and need to understand how effective arguments are developed. Persuasive speech can be used to construct arguments in favor of one side of an issue as opposed to another.

Good Arguments

Below are some guidelines to use with students to help them learn how to develop and present good arguments to persuade others of their point of view. These guidelines have been paraphrased in a student-friendly format from *The New Science Literacy: Using Language Skills to Help Students Learn Science* (Thier and Daviss 2002). See Figure 1 for the original guidelines as they were presented before paraphrasing.

Persuasive Strategies Guidelines for Students

When I want to convince my classmates of my point of view, I:

1. Begin by stating the main ideas of the issue, explaining my point of view and why it is important to believe the way I do.
2. Clearly state my point of view in detail, present more information about my ideas and some evidence.
3. Include only information that supports my ideas and omit the rest.

Figure 1.

Guidelines for Using Persuasive Strategies from *The New Science Literacy: Using Language Skills to Help Students Learn Science* (Thier and Daviss 2002, p. 83).

These guidelines can easily be converted into an assessment rubric.

The student:

- Engages the audience by establishing a context, creating a voice, and otherwise creating reader interest. (Students shape their arguments according to an overriding point of view. They begin their argument by laying out the main idea of the argument, ideas related to the argument, and why it is important.)
- Develops a controlling idea that makes a clear and knowledgeable judgment based on evidence. (States clearly the position of the person speaking along with information and evidence for that position.)
- Includes appropriate information and arguments to support the main idea. (Includes only relevant ideas and arguments in support of the ideas presented.)
- Excludes irrelevant information and arguments. (Includes only the most important sides of the argument and does not lose focus.)
- Anticipates and addresses audience concerns, counterarguments, or other points of view. (Directs arguments to possible positions this particular audience might have and uses evidence to support the arguments presented. Uses evidence to refute other positions in favor of the position argued. Targets interests of audience.)
- Supports arguments with detailed evidence, citing sources of information as appropriate. (Uses evidence to support the advocated position and clearly states where the evidence comes from using notes to remember key points.)
- Provides a summary or closing to the argument, clearly stating conclusions. (Summarizes point of view by emphasizing and restating final compelling arguments.)

4. Try to focus my argument and include only the most important points.
5. Try to figure out what other arguments there could be that are not like mine. I state those arguments and offer evidence against them.
6. Support my argument with all the evidence obtained from research. I use notes to remember my key points.
7. Summarize my argument and restate the evidence that I think is very strong and will convince my classmates.

In the Classroom

Now I will share an example of how these guidelines can be applied in the classroom. The Mystery Spill (SEPUP 1997) is a guided inquiry activity that helps elementary students connect science experiences and social issues. The investigation introduces fourth-, fifth-, and sixth-grade students to aspects of chemistry through a real safety issue: the transport of hazardous materials. In addition, the activity extends the connections between language and science, and students have the opportunity to use persuasive strategies to debate their points of view.

Literacy and Science Processing Skills

The activity begins with the simulation idea that there has been an unknown white powder spilled on the road. Students must determine whether the substance is acidic because that is the first step in determining how to clean up the road. If the substance is dangerous, then an important related question to be debated becomes the issue of transporting dangerous substances in populated areas such as near school sites.

The students begin by discussing various ways to determine how the white mystery substance might be tested. Does it burn? How does it react to water? Students use their language skills to compare and contrast different approaches, to make inferences, and to predict how different substances will react under different circumstances.

Each work group of four students is then given a small amount of six different white substances that each simulates a hazardous material. In reality, the substances are citric acid, flour, detergent, baking soda, table salt, and sugar, respectively. Even though the students are working with ordinary household substances, they wear eye protection goggles for safety. This experience more accurately simulates how scientists work in the laboratory.

As students conduct the inquiry activity, they use science process skills. These skills also closely mirror literacy process skills. For example, students note the details of each material's physical appearance and record their observations in a data table. At first glance, the skills of science might not seem similar to those of language, but when we look deeper, we see that the two disciplines are based on a foundation of parallel or reciprocal processes. For example, when scientists are at work on an experiment, they might also use processes such as comparing and contrasting, predicting, linking cause and effect, distinguishing fact from opinion, making inferences, drawing conclusions, and using language to communicate a practical understanding of their work so that others can understand and replicate what they have done.

In addition to collecting experimental data, scientists often keep a personal notebook or journal to reflect and comment on their work. It is important that we give students similar opportunities to reflect on the work they are doing in the science classroom by providing a section of their notebooks for personal reflection. A science notebook should be more than a record of data collected, facts learned, and procedures conducted. It should also be a record of the students' reflections, questions, speculations, and decisions. These reflections can serve as the teacher's window into a student's understanding of scientific concepts and their ability to express that understanding. Prompts such as "What new ideas do I have now after completing this investigation?" and "How can I use what I have learned in my everyday life?" can help students begin the process of reflection.

Analyzing Data and Thoughts

Next, students test each material with moistened pH paper and note the color of the paper after the reaction. Finally, students add 20 drops of vinegar to each substance and observe the details of the reactions.

The students describe all results in their data tables.

The teacher explains that the white mystery substance is among one of the six kinds of materials the students have tested and that they must now determine which one matches the mystery powder. Each work group tests a small amount of the spilled powder with pH paper and then with vinegar. They compare and contrast the results with those listed in their data tables for the previous six materials tested, make inferences, and draw conclusions about the mystery spill's identity. Students need to continue to use their science notebooks to keep all of the data they collect including their inferences and their conclusions based on their data and observations. This gives teachers evolving insight into their students' thinking. The activity not only helps students understand that language is the repository of information, but also shows them the importance of using good scientific practice. They learn that understanding the correct sequence of events is a necessary step in gathering information; they move from observation to inference and then to an ability to draw conclusions about which substance matches the spilled white mystery powder.

Discussing Issues, Extending Learning

To continue the scenario, the teacher then displays a poster showing the colors and wording of eight diamond-shaped placards from the U.S. Department of Transportation that are used to identify the contents in the trucks that carry hazardous chemicals. Each placard shows the word for the kind of material inside—"radioactive" or "infectious substance," for example—and the distinctive logo that represents that category of hazard. The poster launches a discussion of the practical meaning of scientific terms such as *flammable* and *oxidizer*. The trucks carrying hazardous materials display these placards depending on the materials being transported.

This activity naturally leads students into the controversy whether trucks with diamond-shaped placards should pass near the school. Typically, students are soon wondering: *Suppose there is a spill like the one we have been studying and a dangerous chemical accidentally is spilled. Should children, people in the school, and neighbors be exposed to the hazards?*" Some students might decide that there are just too many trucks carrying hazardous materials past the school. Some students might think that the trucks should be banned from traveling through town. Other students may argue that there could be parents who work at a factory that uses those hazardous materials and their children may fear that their mothers or fathers will lose their jobs if such a ban is implemented. The resulting discussion could lead to additional research on the internet: *What is the likelihood that there will be a spill? What has been the frequency of chemical spills in other communities? How many people could be affected? What could the damage be?* As a result of the activity, the students brainstorm many possible arguments for and against banning the trucks from passing near an area where there is a large population at risk.

Supporting Opinions With Evidence

The students then can read to find scientific evidence to support their opinions. Some might write letters to the editor of the local paper presenting evidence that might predict the odds of an eventual spill; others may write newspaper editorials comparing and contrasting the odds of a spill with the possible economic consequences for the town of banning the trucks. Doing this kind of writing, the students can use the Persuasive Strategies Guidelines for Students described earlier (Figure 1) and the data in their science notebooks to help them.

At this point, students can arrange a mock debate before a "city council" of their peers or parents, using the evidence they have collected to argue either side of the issue. Throughout the activity, students constantly employ the processes of literacy to sharpen and illuminate their understanding of scientific facts, concepts, and processes. At the same time, they can use their newly gained scientific knowledge to shape their use of argumentation in articulating evidence-based decisions and making their cases to others.

Effective Debate

Whatever science activity you use with students prior to their debate, students need to understand that to be persuasive, they must shape their information and argument according to an overriding purpose and be thorough in researching and providing information. They must prepare their presentations by targeting the interests of the audience and using notes to remember key points. Finally, they must engage the audience as they speak, doing so in part by projecting their own personalities.

In this activity, students acting as council members must listen well enough to probe the strengths, weaknesses, and effectiveness of the ideas and persuasive structure within each presentation. Other students in the audience need to listen carefully to rebut arguments against their own positions. It is essential to reinforce the idea with your students that listeners are not passive and need to be actively engaged.

As the teacher, this kind of an activity gives you an opportunity to assess your students' understanding of the activity's science content while also gauging their abilities to use language to articulate, defend, question, and demonstrate an understanding of a point of view derived from evidence.

Additionally, when students use argumentation in this way, it is important for them to personally reflect about their speaking and listening experiences and to use those reflections as tools for personal improvement. Engaging in reflective dialogue with peers helps students become more effective communicators.

Closing Thoughts

When giving students the opportunity to use argumentation as part of their learning, we can see that scientific knowledge can be socially constructed and communicated in the science classroom. Also, the processes of science and the way science works can be further reinforced because students learn that the goal of using scientific argumentation is to build consensus based on evidence rather than on compromise as is done through the democratic practice of voting. Further, when students learn to use evidence to construct and support their arguments, they grow conceptually because they need to think through their arguments and apply the evidence that fits with the arguments they are using. The listener of the argument, alternatively, has an opportunity for conceptual growth as well because they can then change their ideas based on the argument's compelling evidence. So, we see the explicit role of argumentation in the science classroom and the potential it holds for adding sparks of creativity and excitement, thus making your classroom a more dynamic space for your students. ■

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Connecting to the Standards

This article relates to the following *National Science Education Standards* (NRC 1996):

Content Standards

Grades 5–8

Standard A: Science as Inquiry

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Teaching Standards

Standard B:

- Teachers of science guide and facilitate learning.

Standard E:

- Teachers of science develop communities of science learners that reflect the intellectual rigor of scientific inquiry and the attitudes and social values conducive to science learning.

National Research Council (NRC). 1996. *National science education standards.* Washington, DC: National Academies Press.

References

Harlen, W. 2000. *Building for conceptual understanding in science*. Berkeley, CA: Lawrence Hall of Science, University of California.

Science Education for Public Understanding Program (SEPUP). 1997. *Chemicals, health, environment, and me (CHEM 2)*. Ronkonkoma, NY: Lab Aids.

Thier, M., and B. Daviss. 2002. *The new science literacy: Using language skills to help students learn science*. Portsmouth, NH: Heinemann.