

PROCESS SKILLS PRACTICE AND



Standardized Tests

*Teaching specific science-
process skills can help students
learn to accurately interpret
science test questions.*

By Ryan Capp

Faced with the prospect of giving fifth graders a state science test, teachers often review previous grade-level science content or use test-review booklets as a method of preparation. While this may allow students to understand testing rules, such teaching practice takes away from sound science instruction where students talk about, write about, and reflect on science.

As a district science coach, I was seeking a more meaningful experience for my fifth-grade students, so I partnered with a fifth-grade teacher to better match the two areas of our curriculum. We knew students were receiving high-quality instruction with research-based, hands-on science kit materials but that a dry test-taking atmosphere was markedly different from their day-to-day instruction. Since the test-taking environment was so different, we wanted students to have some thinking tools with which to approach standardized tests.

We felt that identifying science processes in test questions in a cooperative learning setting would allow

students to better understand the intent of the question. With this tension between test-preparation and instructional practice in mind, we set out to design a small-group literacy lesson that uses science experiments as a background for learning *and* helps students learn how to read test questions for science-process skills.

Preparations

In the lesson shared in this article, we focused on the concept of *validity*. At the fifth-grade level, an experiment is understood as *valid* if the variables are controlled so the result can be directly related to the tested variable. We know validity is not a concept in every set of state standards, but the lesson template could be used to focus on a variety of science-process skills and concepts, including predictions, conclusions, reliability, variables (independent and dependent), control and test groups, or graphing results.

Because we wanted students to discuss their ideas, we organized students into cooperative learning groups of six to seven students for experiments. Also, we thought it was important that students have a common learning experience to refer to, so all the students completed the "Swingers" pendulum activity from Variables science module (FOSS 2003). In this activity, students explore what factors affect and do not affect the behavior of pendulums. They change the string length (dropping height of the pendulum) and the weight of the object on the end of the pendulum.

Students use science notebooks in which to record their investigations. Notebooks have a table of contents, writing, drawings, predictions, and data, and conclusions. These notebooks are part of our expected science curriculum and closely follow the notebook structure recommended by Michael Klentschy in *Using Science Notebooks in Elementary Classrooms* (2008).

The Process

After student groups conduct the experiment, each cooperative group gathers together to discuss the experience. The teacher asks each group to describe their experiment and then reflect on what went wrong or what could go wrong. It is important to share potential as well as real problems so the teacher knows if students were thinking ahead about controlling for the experiment or if they worked without thinking ahead. While students share their potential or real problems, the teacher starts a chart like the one shown in Figure 1, p. 30. Students complete a similar chart in their notebooks. This questioning gets to the root of what validity means: each chart item shows a variable and how it was or wasn't controlled by the students.

After each student speaks and students have the first column filled, label the second column "result." Model

with students how to write what goes in the result column. For example, if the problem is "my pendulum weight fell off and it didn't swing," the result *might* be "the number of swings on our pendulum was affected because there was not enough weight for swinging." Of course this is incorrect science, because weight doesn't affect the number of swings in a given time period for a pendulum. Students *can* make predictions that may or may not be correct, because the teacher will understand the misconceptions about the science as well as what they do know. It's much easier to adjust instruction later when the teacher identifies the holes in the learning.

Have students complete the rest of their chart on their own, and then report to the teacher and each other. Group discussion should focus on how they can control for variables and focus on the concepts of the lesson as well. They should have their science notebooks open to the pages used for the most recent experiment, in case they need to refer to their experimental data.

Now ask a student volunteer to choose one problem and result they would consider "not fair" to the other experimenters in the class and tell why they think it so. A *fair test* is a valid test, where the experiment is controlled so only one variable is tested at a time. Follow up by asking each student to write a response using this sentence starter as a prompt: "I think our test was (unfair)/(fair) because . . ." For example, a student might write, "Our test wasn't fair because when one of our members kept pushing the pendulum down instead of just dropping it, the pendulum went too fast and changed our data," or, "Our test was fair because we carefully measured and dropped the pendulum from the same exact height every time."

Now introduce the term *validity*. You can describe it as part of "test fairness." Connect the word *valid* to how they conducted their tests. You might say *validity* is a specific word to describe test fairness. If a test is valid, we know the variables—like how and where to drop the pendulum—were controlled or experimented with "fairly." Ask each student to define *validity* in their own words. Students tend to say *validity* is being sure no one messes up the test, or that *validity* is when you test only one thing at a time.

Next, bring out a suitable example from your state science test (one that is not a multiple-choice question) that asks for factual knowledge but with a question that goes directly to the concept you are targeting. With our fifth graders, we used released questions no longer in use from our standardized state tests. We asked students not to fill in the answers. Instead, we asked students to identify the questions on the test that were about validity and asked them to describe how the question was about validity. Following are two questions that students analyzed:

Figure 1.

Chart

We pushed the swinger down	We don't know if the number of swings was high because we pushed it or not
The weight at the bottom of the swinger didn't make the string tight	The swinger would probably have swung more times
We changed the string length to see if it would change the number of swings, but we forgot to drop the swinger from the same place	We don't know if the string length or the dropping point made the difference in the number of swings
We tried different weights, but when we tied the weights on, we think the string length changed	We don't know if the weights or the string length made a difference in the number of swings.

- Question 1: Describe one of the processes that could be used to separate a mixture of iron filings, wood shavings, and salt. Be sure to include all steps.
- Question 2: Evaporation Investigation
Three groups of students decided to design experiments to learn more about the process of evaporation. One group of students used four different containers. The students poured 100 milliliters of water at 20°C into each container. The containers were placed side by side on a table near the window for 24 hours. The next day, the students used a graduated cylinder to measure the amount of water left in each container. Explain why the students put the containers side by side instead of putting each container in a different room.

Question 1 is not about validity. It's about knowledge of physical properties. However, Question 2 is about validity. When students explain placing containers side by side, they should explain how that act controls a variable.

The purpose of this reading activity was for students to think about the kind of question they were reading as well as the answer. Analyzing the question's intent made students think about the thinking; they had to step away from trying to answer the question and essentially be question writers.

The project was a great success. Not only did students get the experience of discussion among peers at a high level, they raised their state standardized test scores 10% from the previous year's group. We attribute much of this success to good instruction and curriculum, but discussing questions at a high level and writing about those questions also factored in strongly to increase student achievement.

Beyond the Answers

Teaching validity in this way helped students reflect on their own understanding and apply that experience to

a new idea. Teachers can then assess students' ability to understand the idea by asking them to recognize the concept in a series of questions. We felt this process opened student thinking beyond the narrow scope of answering a question properly. Students made connections between a science process (validity) and the kind of questions asked on state-mandated tests. The hope is that students will better recognize what kind of question they are being asked and be more likely to answer with well-chosen vocabulary that shows their understanding of the question. Help your students become thinkers as well as answerers! ■

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References

- FOSS. 2003. *Variables module*. Berkeley, CA: Lawrence Hall of Science/UC Regents.
- Klentschy, M. 2008. *Using science notebooks in elementary classrooms*. Arlington, VA: NSTA Press.

Connecting to the Standards

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

Teaching Standards

Standard B

Teachers of science guide and facilitate learning

Standard D

Teachers of science design and manage learning environments that provide students with the time, space, and resources needed for learning science.

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