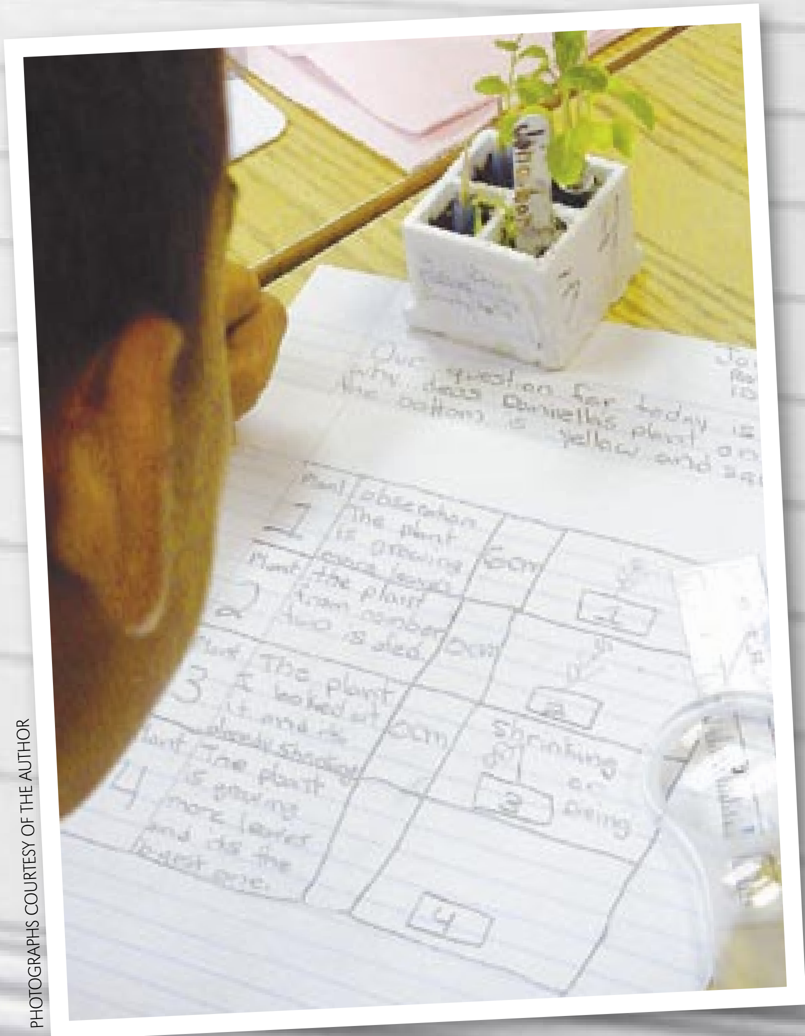
# Science Notebook ESSENTIALS




PHOTOGRAPHS COURTESY OF THE AUTHOR

## A guide to effective notebook components

The science notebook is more than a record of data that students collect, facts students learn, and procedures students conduct. It is also a record of students' questions, predictions, claims linked to evidence, conclusions, and reflections—all structured by an investigation leading to an understanding of "big ideas" (not factoids) in science. A science notebook is a central place where language, data, and experience work together to form meaning for the student.

**By Michael Klentschy**

And, when literacy skills are linked to science content, students have a personal and practical motivation to master language as a tool that can help them answer their questions about the world around them (Thier 2002). Language becomes the primary avenue that students use to arrive at scientific understanding.

Teachers participating in professional development through the Valle Imperial Project in Science (VIPS) know that science notebooks are an essential means of communication. This longstanding collaborative partnership between 14 school districts, Imperial Valley College, and San Diego State University–Imperial Valley Campus, in Imperial County, California, has been putting notebooks at the center of professional development in science for K–8 teachers in this region for more than a decade. Infused through all VIPS professional development initiatives (whether focused on deepening teachers' content understanding, implementing best practices in pedagogy, or increasing teacher understanding of student learning) is the idea that the act of writing by its very nature may enhance thinking. Writing achieves this by demanding that the student organize language. Student science notebooks—used well—give not only stability and permanence to student's work but also purpose and form. Thus, we share VIPS's six research-based science notebook components and associated criteria for each one (Klentschy and Molina-De La Torre 2004):

- Question, Problem, Purpose
- Prediction
- Planning
- Observations/Claims-Evidence
- What Have You Learned?
- Next Steps/New Questions

These six components form the basis for investigative science and establish a basis for students to make meaning from their science instruction. Teachers can use these components and associated criteria to examine student understanding of the concept being taught, identify any misconceptions, and plan subsequent instruction.

While these six components will be found in student science notebook entries associated with most lessons, they are not necessarily found in student entries for all lessons.

## Question/Problem/Purpose

Every investigation begins with a question—*What do we want to find out?* As students begin asking questions, teachers can guide them toward questions that are investigable and help them avoid "yes" or "no" questions.

"How" or "what" questions are usually the best questions for elementary students, as they are more likely to be investigable. On the other hand, "why" questions are often complex and difficult to investigate by their very nature and therefore difficult to investigate. Teachers can help students frame questions by initially providing them with stems such as, *What … ?* and *How …?*

Teachers can also work with students in turning questions that are difficult to investigate into questions that are easier to investigate. For example, when a fourth-grade student asks the question, "Why did the light bulb light when we connect the wires, battery, and bulb?" the teacher can work with the student to reframe the question into, "How can we connect the battery, wires, and bulb to make the bulb light?" or "How many ways can we connect the battery, wires, and bulb to make the bulb light (or not light)?" From answering this investigable question, students will develop an understanding of the process of a complete circuit and the function of the wires, battery, and bulb in the development of a circuit.

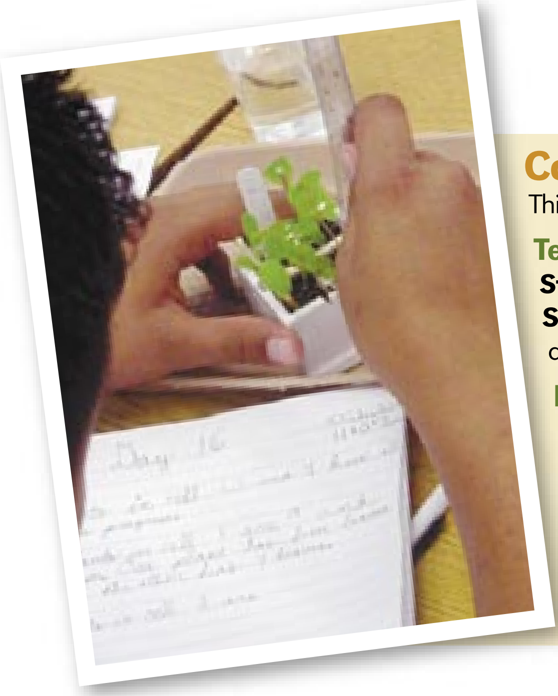
When the science investigation is related to a "real-world" problem, students usually frame richer questions. Teachers should try to use current events to help students make real-world connections. One such example could be, "If a storm caused the power to go out in your house and you had a wire, a battery, and a bulb, how could you make the bulb light so you will not be in the dark until power was restored in you house?"

## Prediction

The next step is eliciting a prediction—in which students focus on what they think will happen as a result of conducting the investigation. Students must be guided not only to state what they think will happen but also state a reason or explanation for what will happen. An effective way to encourage this is with conditional statements, such as *If… then …*and *I think … because…:*

- *If* more magnets are added to the magnet stack, *then* more washers will stick to the magnet.
- *I think* that the strength of the magnet will become stronger with more magnets added to the stack *because* more is better and stronger.
- *If* more washers are added to the bottom of the string, *then* the pendulum will swing more cycles because of the weight.
- *I think* the pendulum will swing more cycles with more washers added to the string *because* the weight will make it cycle more times.
- *I think* we can use evaporation to separate the salt from the water *because* I saw water dry on my dad's car and it left a spot.

The prediction must be clear and reasonable and relate to the question. Predictions will often provide the teacher with insight into student thinking, prior knowledge, and existing misconceptions. For example, when examining cheek and



## 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 C:** Teachers of science engage in ongoing assessment of their teaching and of student learning.

### Professional Development Standards

**Standard B:** Professional development for teachers of science requires integrating knowledge of science, learning, pedagogy, and students; it also requires applying that knowledge to science teaching.

### Assessment Standards

**Standard A:** Assessments must be consistent with the decisions they are designed to inform.

onion cells under a microscope, a fifth-grade student wrote the following prediction, "I think I will see a difference in colors between cheek and onion cells because I know an onion is clear and a cheek is sort of red." Later in the investigation the same student wrote, "my evidence does not confirm that there are colors in either cheek or onion cells. Both cells had no color. I could see the nucleus of both cells and their cell walls. I learned that scientists add coloring to the cells so that they can see the cells easier."

## Planning

Planning criteria relate to how the investigation will be conducted. The plan should relate to the investigable question and include the sequence, materials, and a data organizer. Teachers should also take care not to place too much of a burden on students spending too much time in the creation of their plan. Young students will tend to list everything and will consume most of their investigation time just listing materials.

In addition to listing materials, the plan should have a clear sequence or direction and identify variables and control. One way to ensure that these criteria are being met is by having a class discussion where different groups briefly share their plan. This way the teacher can spot-check student plans to be sure each group is staying on task.

The data organizer—a means used by students to collect their data in an organized fashion—may be the most difficult portion of the plan for the students to create. The patterns and relationships in the data organizer assist students with their conceptual and procedural understandings.

Teachers should hold a class discussion with students sharing the type of data organizers they have created as part of their plan to provide students who are having difficulty a chance to examine peer examples of data organizers.

Possible data organizers include:

- Tables,
- Charts,
- Tables,
- Graphs,
- Venn diagrams, and
- Labeled pictures and diagrams.

After the class discussion, the teacher may want to share a class data organizer to guide students and to serve as a basis for class discussion during the "making meaning conference," which will occur later in the investigation. The making meaning conference is a planned classroom discussion that uses the graphic organizer to display the results of the investigation in such a way that patterns or relationships in the data become evident to the students. Cumulative knowledge is built as groups share their results and replications within the same investigation.

## Observations/Data/Claims-Evidence

During the activity or investigation, teachers guide students to record in the graphic organizer in their notebooks what they actually see and do, not what they think the teacher expects them to see or do. This helps students make meaning that is their own (knowledge transforming) compared to what they think the teacher expects them to tell (knowledge telling). This provides students an opportunity to develop voice and construct meaning from their science instruction.

Student observations don't have to be restricted to writing—drawings provide students with a means to shed their preconceptions and see what is actually there (Harlen 2001). Drawing, sometimes referred to as "graphic speech" (Vygotsky 1978), can act as a guide to student's understanding of science content. In addition to labeled drawings, students should record charts, graphs, and narrative.

Teachers should plan to use collected data in a way that will help students form claims related to the evidence they collect. This can help the student form meaning through class discussions of the claims and associated evidence drawn from their science notebook entry from the science activity. For example, a group of students might predict that the seed pods highest on the stem would produce the fewest number of seeds on a *Brassica* plant. After examining the data produced (number of seeds) when the pods were opened, the students may discover that the pod highest on the stem yielded the most seeds and that there was a relationship between the number of seeds in a pod and its position on the stem.

## What Have You Learned?

The purpose of this notebook component is designed to assist students in interpreting and explaining their investigation results, while also reflecting on their existing understandings. Students must use their claims and data to support their written and drawn conclusions. This is the most difficult task for students because it pushes them to draw conclusions based on their own interpretations—using the evidence collected during the investigation (Shepardson and Britsch 2001).

Classroom discussions during a "making meaning conference" help students form their own conclusions as they hear the claims and evidence of other students.

Finally, students write reflections about their science activity and return to their initial predictions (affirming or revising) and questions, summarizing what they have learned and how their ideas have changed. Written reflection is essential to promote student's explorations of their own thinking and learning processes, but it is often omitted if science notebooks are used primarily as logs for procedures and observations of their learning activities.

## Next Steps/New Questions

The progress or outcome of a science investigation may stimulate students to think of new questions that they would like to investigate. Encourage students to record these questions throughout their science notebooks. Just as when framing initial questions for the activity, the questions should be investigable. They should also be extensions or new applications of the original question.

For example, after students discovered several ways to light a bulb with a wire, battery, and bulb, some wrote new questions in their science notebook, such as, "What would happen if we used two batteries?" and "What would happen if we used two wires?"

After students think of new questions, provide them with opportunities to investigate these questions with extension activities. In this case, the teacher placed a supply of batteries, wires, and bulbs in a center so students could further investigate their questions.

Encouraging students to build on investigations with their own questions provides for individual differences and gives them opportunities to go deeper into their investigation of the phenomena.

Something else to look for in students' questions is the "WOW" factor—this is when a student makes a reflective statement that demonstrates deeper thinking. When students investigated the effects of sunlight on construction paper and found that it faded the construction paper, one fifth-grade student wrote, "I wonder if your skin would eventually fade in the Sun?" Student questions like this provide an ideal opportunity for a class discussion or an extension of the original investigation.

## Achieving Through Notebooks

In the Valle Imperial Project in Science, the key to effective science teaching was to enable students to develop ideas and personal meaning about the world around them that fit evidence they collected.

Studies have examined the impact of VIPS' high-quality program of instruction—which includes the use of notebooks in science—on student achievement in science (Amaral, Garrison, and Klentschy 2002; Klentschy and Molina-De La Torre 2004). These studies revealed positive results—particularly that providing a "voice" for students through their science notebooks has led to increased student achievement in science and in reading and writing as well. ■

***Michael Klentschy* (mklent@ecsd.k12.ca.us) *is Superintendent of Schools at the El Centro Elementary School District in El Centro, California and Principal Investigator for the Valle Imperial Project in Science.***

### Resources

Amaral, O., L. Garrison, and M. Klentschy. 2002. Helping English learners increase achievement through inquiry-based science instruction. *Bilingual Research Journal* 26(2): 213–239.

Harlen, W. 2001. *Primary science, taking the plunge.* (2nd ed.) Portsmouth, NH: Heinemann.

Klentschy, M., and E. Molina-De La Torre. 2004. Students' science notebooks and the inquiry process. In *Crossing borders in literacy and science instruction: Perspectives on theory and practice* W. Saul (Ed.). Newark, DE: International Reading Association Press.

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

Shepardson, D., and S. Britsch. 2001. The role of children's journals in elementary school science activities. *Journal of Research in Science Teaching* 38(1): 43–69.

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

Vygotsky, L.S. 1978. *Language and thought.* Cambridge: MIT Press.