Learning Logs:

Writing to Learn, Reading to Assess

Learning logs help teachers assess understanding of science content.

By Daniel Heuser

Just what do children get out of inquiry? Good inquiry activities help students hone their inquiry abilities and teach them about the nature of science. But inquiry is also a way to teach science content, and teachers need to know if this instruction is helping children gain these important ideas. So, how do we know what students are learning? Try a "Learning Log," a tool to help build knowledge from inquiry activities. This article describes a color and light activity I did with my first and second graders, and how a rubric for learning logs helped me to make accurate judgments of what my students learned. However, learning logs can be uses effectively in any grade level and on many topics.

What Is the Hottest Color?

"What is the hottest color?" asked a student one day as we brainstormed questions during a lesson on color and light. This seemed like an excellent question to help consolidate our unit. As we discussed the question, it became clear that to many students the answer was simple: red is the hottest color. Why? "Because it's the color of fire."

When I held up a piece of aluminum foil, however, many of their initial thoughts changed; silver became the hottest color of choice, because "it's metal, and metal is hot" and "once I touched some aluminum foil at a picnic, and it felt hot."

This question focused so well on the unit objectives—light produces heat and can be reflected and absorbed and that materials of different color react differently to light—that I wanted the whole class to investigate. So, as a group, we designed a plan to answer this question and help students refine their natural inquiry abilities. Several issues arose as we discussed possible investigation plans.

First, it became obvious that most students thought that they could tell small differences in temperature with their hands. I challenged several students to close their eyes and tell me which of two pieces of paper (one red and the other a lighter color) was the "hottest" just by touch. After a few trials in which students inconsistently picked the "warmest" paper, the group started to entertain the idea that the hand was not the best device for this task.

Soon, a child suggested using thermometers, which gave me a chance to point out that scientists use instruments such as thermometers because they increase accuracy.

A second opportunity for children to refine their inquiry abilities came when we had to decide where the papers would be placed in relationship to the afternoon Sun. To several students, it was a given that the paper closest to the Sun would be the hottest—even though the few feet involved was nothing in comparison to the Sun's five million miles distance from Earth. This seemed like a natural point for me to bring up the idea of multiple trials. "Scientists have a way of dealing with that problem," I said. "We could put out two pieces of each paper color, one closer to the Sun and one further. That way it will make our test fair for all of the colors. We can also see if it's the color that makes a difference or the distance from the Sun."

Soon we had our investigative plan: We would put pieces of paper in several colors—plus a sheet of aluminum foil—out in the Sun during their music class. A thermometer would be placed on top of each. After music class we would read the thermometers and see what happened. The results are shown in Figure 1. Thanks to our using some fairly high-quality thermometers, there was only one degree difference in our two sets of blue paper. Because of this, we later had a discussion about how instruments can lead to varying measurements.

Time for Reflection

Each science investigation I conduct ends with reflection in which we talk and write about the activity. I guided the conversation by providing several discussion prompts:

- What is the hottest color?
- Why do you think that is?
- What else did you notice about the data?
- Have you ever noticed how some colors seem hotter than others when you are outside?

Students shared their thoughts, debating several interpretations and explanations of the data. Their ideas reflected their varying abilities. While trying to explain why the black paper was the hottest, one child said, "the Sun is trying really hard to warm the black paper up." Another shared a more sophisticated explanation by suggesting the idea of materials reacting with light: "Black holds light in it, but white doesn't." A third child expanded on this comment by describing how "you're not supposed to wear a black shirt on a sunny day because you'll get too hot because black absorbs the light." Note that this child used the term "absorbs" and brought up a practical application of absorption.

We also discussed that even though our investigation question asked "What is the hottest color?" it's not actually colors themselves that were hot but that colors absorb or reflect heat in differing amounts. This post-activity discussion is vital preparation for constructing new knowledge during the learning log writing that follows (Rivard and Straw 2000).

Is this the time to teach children what happens at the molecular level as light and colored materials meet? No. It is more important that inquiry for children of this age should focus on observable phenomena. According to the *National Science Education Standards*, "the changes that occur when materials interact provide the necessary precursors to the later introduction of more abstract ideas in the upper grade levels" (NRC 1996, p. 121).

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Learning Logs

Following our discussion, I usually put two writing prompts on the board for my students to respond to in their learning logs. The first is simply to answer the inquiry question—in this case, "What color is hottest?" The second prompt is to help children extend their knowledge beyond the initial question.

This second prompt is usually quite general so that children can take aspects of the activity and discussion and build knowledge in directions that best fits their abilities and interests. For this lesson, the second prompt was "What does sunlight do to papers of different colors?"

Writing about science experiences can be difficult for children. I've found it best to start using learning logs early in the year with my first graders so that they become accustomed to the task. In fact, I now start so early in the year that sometimes I cannot even read their writing, and I have students dictate their responses to me. I'm not able to do this with every student every time, however, and that's okay. The power of reflective writing is more in the thought that the writer puts into it, rather than the final product.

Figure 1.
Experiment results.

Color	Temperature
Black	103°F (39°C)
Blue	98 and 99°F (36°C and 37°C)
Red	91°F (33°C)
White	90°F (32°C)
Silver (aluminum foil)	89°F (31°C)

Explanation: Darker paper absorbs more of the Sun's rays, and visible light energy is converted to heat energy. Aluminum *reflects* more of the Sun's rays.

Figure 2.
Learning log rubric.

Level	Student	Examples
4	Correctly interpreted results to answer the question, and included *two* other pertinent comments (explanation, application, generalization, or justification).	**Explanation** • The sun is attracted to dark colors. • The sun was trying very hard to make black a light color. • Black absorbs heat. Light colors like silver will reflect light. • Black made the light stay in it. • The sun pays attention to the darkest colors like black. **Application** • If it is a hot day you should wear light colors to stay cooler. • That's why blacktop is so hot on your bare feet. **Generalization** • No matter where the color is if there are two of the same colors they will always be the same temperature. • Different colors are different temperatures. • Dark colors are hot, light colors are not. **Justification** • Black is the hottest. The black thermometer was the highest.
3	Correctly interpreted results to answer the question, and included *one* other pertinent comment.	(shown in level 4 examples)
2	Correctly interpreted results to answer the question.	• Black is the hottest, white is the lowest, yellow is in the middle. • The hottest color is black.
1	Incorrectly interpreted results.	• Yellow is the hottest color because it's the color of the Sun (ignored, was not swayed by, or did not understand data.) • Tinfoil is 89, black is 103, blue is 98… (listed data without interpreting it).
0	Log provided little or no information in which to make a judgment.	Includes logs that are illegible or off topic.

Here are several other tips for using learning logs:

- Generally, spelling and punctuation can be ignored. I want students to put thought into the content rather than the conventions.
- Have students write to a time limit. "Everyone writes for 10 minutes," usually leads to more detailed and thoughtful writing than simply asking children to respond to the prompt. I do not accept an "I'm done" before the time limit is over. Instead I encourage students to expand their thoughts. Challenging them to fill out a whole sheet (or two) is another motivator.
- Circulate and read children's logs as they're writing. For adults it is considered rude to look over another's shoulder. With learning logs, however, it is a crucial habit to get into. As I read what students are writing, I often ask for clarification, ask questions, and offer encouragement. These probes push children to build new understanding.
- Finally, read and learn from the finished entries. Using a rubric makes the assessment of learning logs easier and more accurate.

Learning Log Rubric

Once students have responded in their learning logs, I assess what they've written. I evaluate each child's response to the first prompt using the rubric shown in Figure 2. At the very least, I want children to reach a reasonable conclusion from the activity. While reflection can and should focus on inquiry processes and other aspects of science, this rubric is for assessing content knowledge.

Basic conclusions are just the beginning, however. Writing that goes beyond reporting results has been called "knowledge-transforming writing" (Bereiter and Scardamalia 1987). For example, research suggests that when students write to explain the results of hands-on activities, they are building new understanding as they connect past knowledge to the inquiry (Palincsar, Anderson, and Daniel 1993). These extensions of thinking often take the form of explanations, applications, generalizations, and justifications, which are described in more detail below.

Explanations

One of the main aims of inquiry is to help children "use their observations to construct reasonable explanations" (NRC 1996, p. 121). The Standards acknowledge, however, that this is a difficult task for many K–4 students. For this reason, the rubric makes no distinctions between explanations that are fairly accurate and complex and those that are naïve and basic. From a constructivist viewpoint, children's explanations reflect their individual experiences and intellects. These early explanations are necessary to the later development of more accurate concepts.

As they were writing, I asked several children, "Why do you think the darker colors had the highest temperatures?" Probes like this lead children to think about explanations.

Justifications

Children should be encouraged to justify their conclusions with evidence, which most often are observations from the investigations. Probes such as, "How do you know that black is the hottest color?" prompt children to back up their assertions with facts, such as that the thermometer on the black paper had the highest reading.

Connecting to the Standards

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

Content Standards

Grades K–4

Standard A: Science as Inquiry

- Abilities necessary to do scientific inquiry

Standard B: Physical Science

- Properties of objects and materials
- Light, heat, electricity, and magnetism

Assessment Standards

Standard B: Physical Science

- Achievement and opportunity to learn science must be assessed
- Achievement data collected focus on the science content that is most important for students to learn

Applications

Children need to see how science is applicable beyond the walls of the classroom. Students who connect conclusions to experiences outside of school or to previous science lessons are applying knowledge. When teachers ask, "Have you ever touched something black that was in the Sun? Write about that!" children think of how these concepts apply in the world at large. An example that may come to mind is, "That's why blacktop is so hot on your bare feet."

Generalizations

Children develop generalizations by identifying patterns across the investigation data. Being able to see beyond the phenomena to an overview of the data is a step toward generating powerful explanations (Tytler and Peterson 2004). "What kind of colors had the highest temperatures?" is an example of a probe that may lead children to generalizations: "Dark colors are hot, light colors are not."

An Authentic, Valuable Tool

With learning logs, no learning time is lost since the assessment—students written log entries—is not separated from instruction but embedded in it. Learning log responses offer an authentic view into students' learning. As students respond to the prompts, they essentially are "…answering the question and presenting the results to others"—part of what inquiry is all about (NRC 1996, p. 122). They are developing inquiry skills in a meaningful way, yet another reason learning logs are such valuable tools for students and teachers. n

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Resources

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