

KLEWS to Explanation-Building in Science

An update to the KLEW chart adds a tool for explanation building

By Kimber Hershberger and Carla Zembal-Saul

Time for an update! In our technological world, we are always getting messages that an “update is available.” The KLEW chart we first wrote about in 2006 is due for an update in order to better harness the powerful learning that constructing this conceptual chart can foster in a classroom. When students are engaged in developing explanations and integrating scientific principles in their thinking, conversations, and writing, the classroom becomes a community of scientists who use evidence to support their ideas and make connections to their everyday experiences. Our KLEWS chart update provides a framework for visually connecting claims and evidence with science vocabulary and principles. We will share specific examples from a grade 3–4 unit on Energy and Electricity to illustrate how the update works.

The *Framework for K–12 Science Education* (NRC 2012) and the *Next Generation Science Standards* (NGSS Lead States 2013) emphasize the importance of engaging students in scientific practices as they learn core ideas in science. These practices include asking questions, developing and using models, planning and carrying out investigations, analyzing and interpreting data, using mathe-



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A student intently examines electrical circuits.

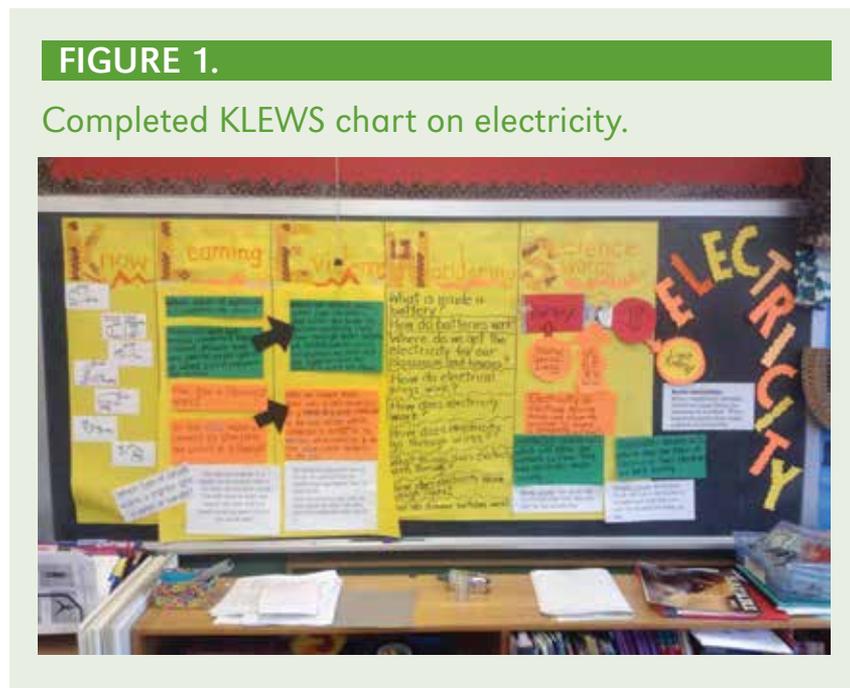
matical and computational thinking, constructing explanations, engaging in evidence-based argumentation, and evaluating and communicating information. Our work in elementary classrooms has focused on enhancing students’ talk and writing by constructing explanations and supported arguments. In particular, we have emphasized the development of core ideas in science through the investigation of phenomena that provide evidence from which young learners can construct claims.

Let’s Get a KLEW

The KLEW chart is a modification of a well-known reading comprehension strategy known as KWL (Ogle 1986). As part of this approach to engaging with texts, students document what they *know* (K), what they *want* to know (W), and what they have *learned* (L). In our adaptation for science teaching (Hershberger, Kur, and Haefner 2013), the components of the KLEW(S) chart are used to document the following:

- K – What do we think we *know*?
- L – What are we *learning*? [claims]
- E – What is our *evidence*?
- W – What do we still *wonder* about?
- S – What *scientific* principles/vocabulary help explain the phenomena?

By framing the K as what we think we know, we can assess and document prior knowledge without having to place initial emphasis on the scientific accuracy of students' ideas. These ideas are revisited and revised as students develop more robust ways of thinking about phenomena. The L and E columns are developed in tandem. As evidence is collected from investigations of phenomena, students are encouraged to look for patterns and construct claims. Arrows are used to represent these connections between evidence and the associated claims. Claims are responses to driving questions crafted by the teacher and used to frame investigations. Often investigations lead to new testable questions. We capture these in the W column throughout the unit and when possible use them to sequence instruction and guide lesson planning (Kur and Heitzmann 2008). Finally, the newly added column, S for scientific principles, is where we identify important ideas and terms that students find in science reference materials. These ideas provide the reasoning for students' overall scientific explanations. The S column also can be modified to include scientists as well as scientific principles. For example, when studying



force and motion, students might add “force” to the S column and attribute related ideas to Sir Isaac Newton. The teacher can guide students to consider the work of scientists who are women and/or from underrepresented groups.

It is important to understand three key considerations about the implementation of KLEWS charts. First, they are organized around driving questions that frame investigations and for which related claims are constructed from data gathered during investigations. Second, the columns are *not* completed in order left to right, but rather through an iterative process of documenting and revisiting columns while constructing the overall explanation. Third, the intention of the chart is to provide visual representation of students' thinking over the course of a unit or at the very least a series of investigations.

Update: Adding the S to KLEW

While teaching a unit on electricity, the class investigated: How can we light a bulb with a battery and one wire? This question is based on the Grade 4 NGSS Performance Expectation 4-PS3-2, “Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electrical currents” (PS3.B: Conservation of Energy and Energy Transfer, NGSS Lead States 2013, p. 35). Working in pairs, students were able to claim that the bulb would light when the wire was used to connect the positive and negative ends of the battery with the metal parts of the bulb. At that point, the students were ready to read and learn more about electricity and how electrical currents work. Using information from the book

Energy (Woodford 2007), students were able to consider the previously learned concept of potential energy as it relates to the battery and light bulb (Figure 1, p. 67). They learned that the battery has chemical potential energy, which transforms into electrical current and ultimately light energy. These ideas were represented with visual diagrams on the KLEWS chart. In addition, we used multiple sources, including websites and videos, to help students learn about the

flow of electrons. While the flow of electrons isn't something students can directly observe, they can certainly experience the results as they complete electrical circuits.

We then asked our students to restate what they learned from the science books and videos to develop what is written in the S column on our class KLEWS chart. Once students had read or heard various descriptions of how electricity works, they were ready to add the follow-

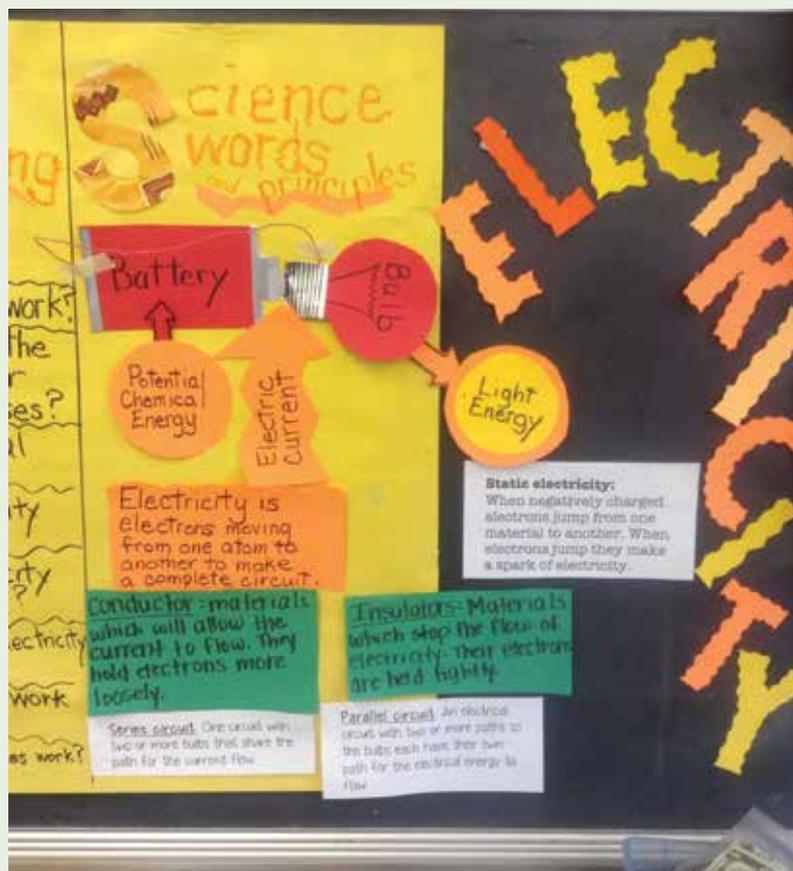
ing definition to the chart: "Electrical current is electrons flowing from atom to atom to make a complete circuit" (Figure 2). We have discovered that when students participate in forming definitions on the chart, they are more likely to use them in class science talks and science notebook writing.

KLEWS to Explanation Building

To help students develop the components of a scientific explanation, we implement the CER Framework, which stands for Claims–Evidence–Reasoning (Hershberger, Kur, and Haefner 2013). The CER framework was developed by McNeill and Krajcik (2012), who demonstrated that by using such a framework, students were supported in constructing more complete evidence-based explanations and that they understood the underlying science ideas better. The framework also supports teachers who engage students in explanation building to focus their instruction and assessment. The KLEWS chart maps directly onto the CER framework. The L and E of KLEWS are aligned with claims and evidence, while the S is related to the scientific reasoning needed to build a complete explanation. More specifically, the S section of the KLEWS chart provides words and principles for students to incorporate in the reasoning portion of their explanations. One student stated, "The reasoning helps to tell the whole story." Adding principles and terms to the S section of our KLEWS chart adds meaning and authenticity to our follow-up science talks. We intentionally move our stu-

FIGURE 2.

The Science words section of the KLEWS chart.



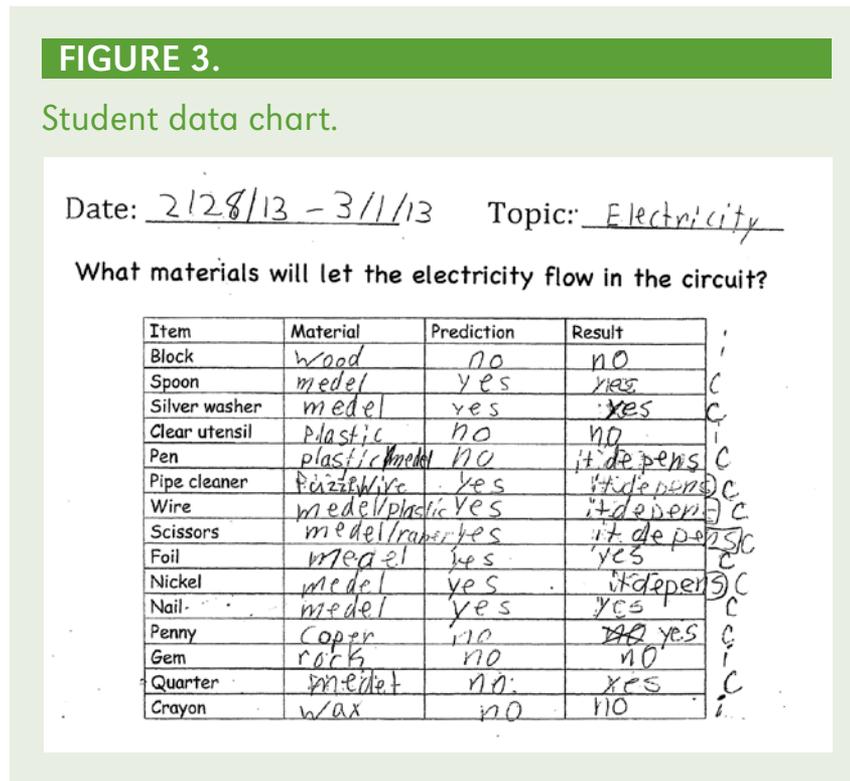
dents from the hands-on investigations to minds-on explanations about their data and observations. The S section helps students use common science terms as they engage in scientific discourse. They share their results and expand on each other's ideas as we collectively construct all aspects of the KLEWS chart during our science talks.

Throughout the unit, we found evidence that students were able to use science vocabulary and principles in their notebook entries. Following an investigation with conductors and insulators (Figure 3), most students included words from the S section, such as *circuit*, *electrons*, *conductors*, and *insulators*, in their explanations. Here is a sample from a third-grade learning support student's notebook. The sample uses CER and the student wrote it using the KLEWS chart for support:

“Claim: Metal items complete the circuit. Evidence: When we tested the nail, the bulb lit because it was made of metal, but the crayon did not work because it was made out of wax. Reasoning: A conductor is an object that allows electrons to move easily from one atom to another - ex: metal things. An object that prevents electrons from moving from atom to atom is called an insulator.”

Why We Use the Update

When we first began to implement a chart to document our science talks, we used the KLEW format. The addition of the S section has profoundly improved this model as it gives us a forum to clearly make connections to vocabulary used in state stan-



dards and NGSS. Now, we always make a KLEWS chart so we have a visual reminder of the important science terms and ideas for the unit. One teacher we work with stated, “I can’t imagine teaching without the S. It helps to keep us focused on the shared language of science. It’s similar to posting a word wall, only it intentionally links the words to the investigations and evidence collected. These connections help students deepen their understanding of the concepts. As the chart builds, it serves as a visual map for the entire unit.”

During our Energy and Electricity unit, the use of science words became cumulative as the unit progressed. One student suggested adding a glossary to their science

notebooks so they could each have a record of the words and concepts added to the S column. By the final investigations, terms such as *circuit*, *electrical current*, *conductors*, *insulators*, and *flow of electrons* were being used by all students during discussions and in their notebooks. One of our last investigations prompted students to observe a flashlight and find out how it works. In their notebook explanations, students referenced ideas from prior lessons on conductors, how to light a bulb, and how switches work. They remembered that the bulb would light on both sides of the battery and were able to add conductors on top of the battery so it would light on the negative side of the bulb (Figure 4, p. 70). Students were comfortable

using the vocabulary because it had been so visually and purposefully linked to investigations.

User Friendly for All

Our university student teachers have used the KLEWS charts as they plan and teach their first science lessons. One student teacher shared, “In science, the experiments can be lots of fun and the students can kind of forget what they are supposed to learn. Using the KLEWS chart helped to anchor the objectives for the lesson and give it a purpose.” Another student teacher shared that before using a KLEWS chart she might have chosen to read a book at the beginning

of the lesson so the students could “learn” the vocabulary first. After using the KLEWS chart as an anchor for lessons, she noted that, “Now, I start with a question, have them investigate, next we discuss what they observed so they can make a claim and support it with evidence. After that, I bring out a science book so we can clarify what we have learned. The students listen attentively to the science content when they can connect it to what they see during their investigations. Finally, they incorporate the science vocabulary in their notebook entries.”

The timing for introducing science principles and terms is critical in the sequence of a science unit.

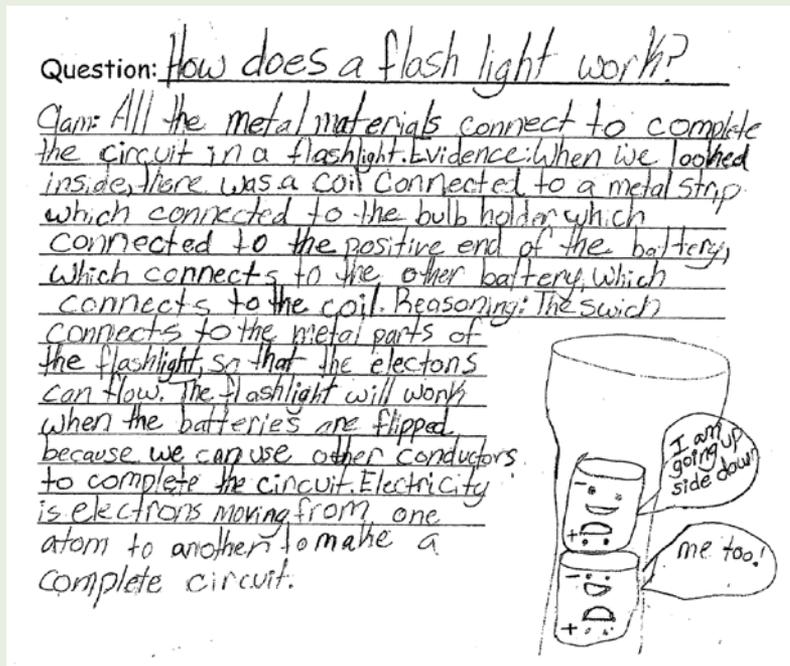
When we start lessons by reading an informational book it may short-circuit student understanding by presenting principles before they have observed and investigated the phenomena. In contrast, when we conclude a lesson by asking students to help write the definition of a science principle they have experienced, they have the background knowledge to help construct what is written on our class chart. Additionally, because students have contributed to the definition, they are able to apply the science words and principles during conversations and written work.

Are You Ready to Install the Update?

There is growing evidence that young children are very capable of engaging in sophisticated scientific thinking (NRC 2007), such as constructing explanations from evidence. While students as early as Kindergarten can connect claims and evidence, it is often difficult to know when and how to begin with incorporating scientific reasoning. Adding the S column to the KLEW chart, scientific principles and terms, can provide that starting point for talking and writing more complete scientific explanations. We have observed this being done successfully as early as first and second grades. It becomes the backbone for investigations as students return again and again to the words and ideas that help them develop deeper understanding of the science. We hope that the KLEWS chart update allows you and your students to take the next steps in constructing scientific explanations! ■

FIGURE 4.

Student notebook entry.



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