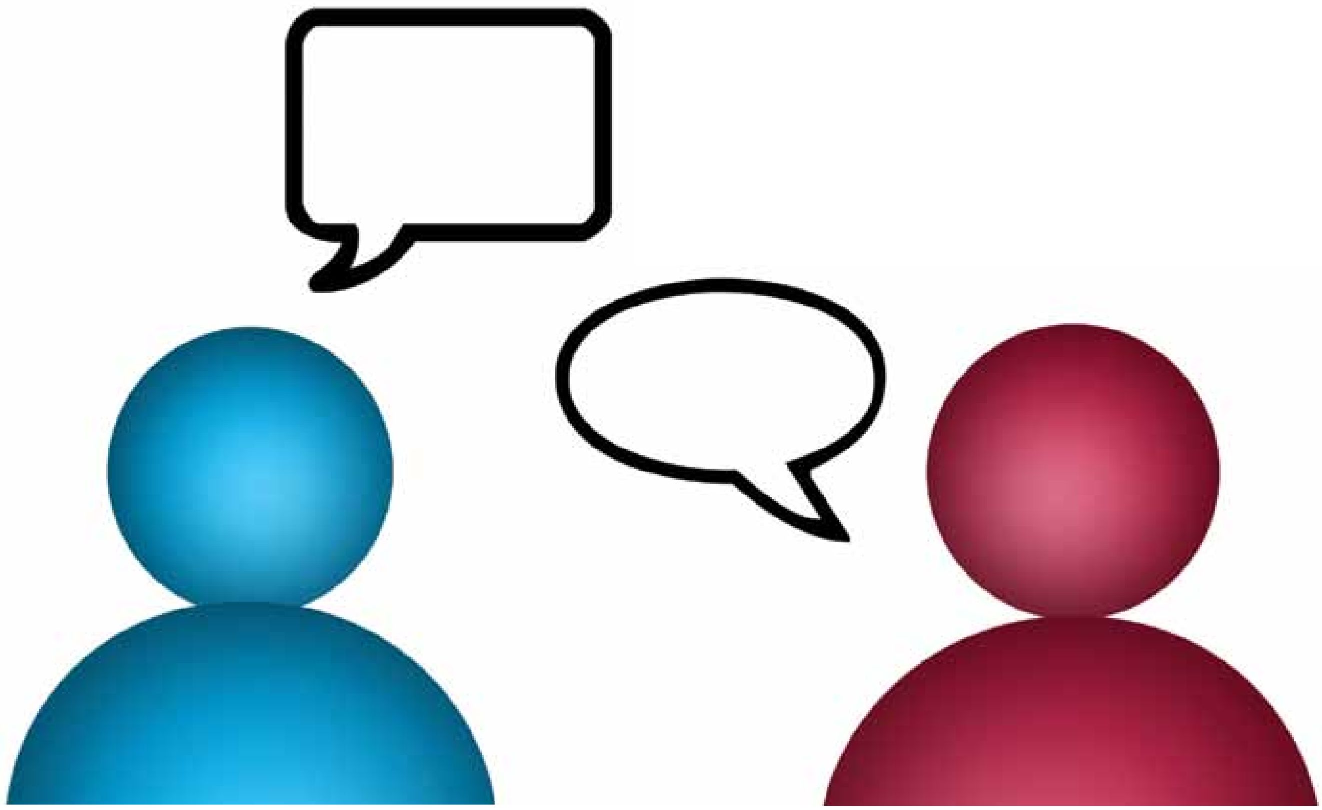


What Does It Mean to KNOW?

THIRD-GRADE STUDENTS RESEARCH USING CLAIMS AND EVIDENCE IN SCIENCE

By Susan A. Kirch and Anna Stetsenko

"When we say we know something, what does that mean?" That's the first question third-grade teachers asked their students as they introduced a unit called *What Is Knowledge and Evidence?* Two teachers used the following example, "If I say something like, *I know there are 230 kinds of bees in the city*, what does that mean? What does it mean when I say *I know*?" Students in these classes replied, "It means you…

- are sure
- read it in a book
- learned it from a scientist
- have to prove it
- researched it
- can bring them to the bees and show them and count the bees and show them it's true."

What do people mean when they say they *know* something in science? It usually means they did an investigation and expended considerable intellectual effort to build a useful explanatory model. It means they are confident about an explanation, believe others should trust what they say, and believe that their claim is testable. It means they can expect to be challenged and called to defend their position, and that their interpretation could eventually be proven "wrong" someday. In addition to these practical implications, when an individual says *I know,* it reveals something about his or her worldview and experiences, maybe even individual motives and goals. In other words, knowledge is inherently personal. Learning is a process that can lead the development of a child (Vygotsky 1978), and learning science can influence whether a child wants to be someone who engages in exploration, explanation, and argumentation.

A New Tool for Teaching Evidence

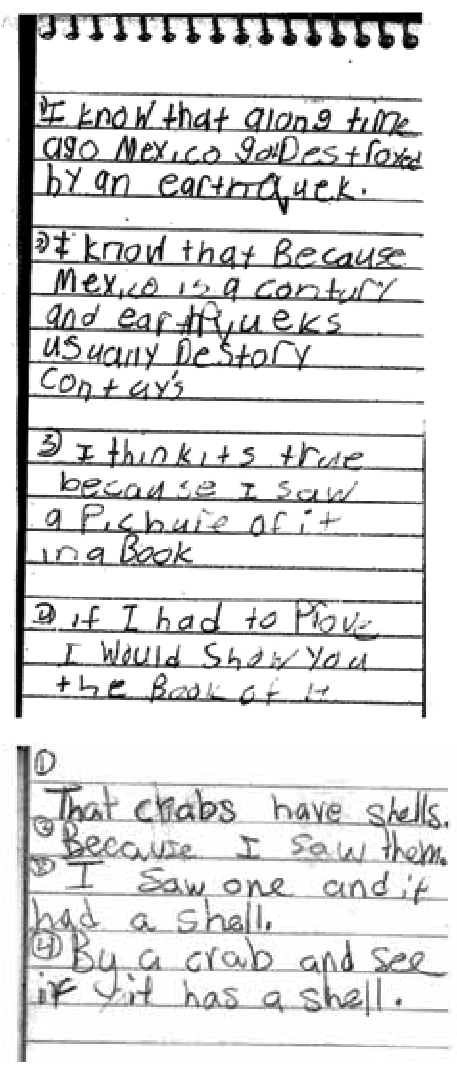
What Is Knowledge and Evidence? is a unit designed to engage students in examining how scientific knowledge is developed and shaped over time. Based on our findings from tests in classrooms, we found this unit (which can be conducted in one week for approximately 30–45 minutes a day) provides elementary school students with an introduction to the purpose that evidence serves in science. This type of introduction to knowledge is an important prerequisite to learning common scientific forms of reasoning.

There are a growing number of resources to help elementary students structure scientific arguments (McNeill and Martin 2011), write arguments in science, and evaluate their own arguments and others' arguments (Norton-Meier et al. 2008). As prerequisites to learning the form of a high-quality scientific argument, it is important to address not only the link between claims and evidence, but also the role of evidence within the overall process of doing science, including processes of thinking, reasoning, and knowing. This broader focus allows for a deeper grasp of evidence such as making sense of the relationship between evidence and a claim.

We worked with 12 third- and fourth-grade teachers and 126 third- and fourth-grade students for two years to design and research new approaches to teaching and learning argumentation. Approximately 17% of classroom participants were receiving special education services and 29% were receiving English as a Second Language services. To make sure our diverse student body understood the questions throughout the unit, teachers allocated time for students to explore and discuss various questions. Here we present a summary of one of the five units on scientific evidence that we developed, *What Is Knowledge and Evidence?*

Figure 1.

(A) Madison as interviewed by Mya.
(B) Timmy as interviewed by Shawna.



Day 1: Set the Stage and Introduce

After a brief introduction to the project team and general schedule, each teacher opened a whole-class discussion with the question: "When we say we know something, what does that mean?" Students explained that it means the person can prove it, that he or she researched it, and that he or she is sure about the information.

Ms. Harris asked her students, "Now, I told you I know that there are 230 kinds of bees in the city, how could you explore what I know? How could you explore how I came to know it? How could you explore if I think it's true?" Students suggested that they could ask her questions about where she learned it or they could do their own research and independently confirm her claim with books or by "Googling it." She agreed and suggested that the students first explore the general method of interviewing. Students were eager to begin. Each teacher posted these interview questions: What is something you know? How did you come to know that? Why do you think it's true? If you had to prove it, what would you do?

Students worked in pairs, interviewed each other, and took notes in research notebooks. Figure 1 (p. 45) shows an example of interviewers' notes and Figure 2 shows an example of a completed chart from a whole-class reporting session. For homework, students interviewed at least one additional person and learned five things the interviewee knew about sound—a topic they were just starting to study in science. Interviewees were called Research Associates and included parents, siblings, relatives, after-school counselors, teachers, and friends. On Day 3, students determined the frequency and sources of evidence identified by their Research Associates. Their further analysis of this data is detailed below.

Figure 2.

Completed chart after discussion of in-class interviews.

PHOTOGRAPHS COURTESY OF THE AUTHORS

Students present a teaching story about evidence.

Day 2: Introduce Terms, Analyze Text

Teachers worked with the students to codevelop definitions for "claim" and "evidence" based on their common experiences of the previous day. For example, Ms. Harris explained that Research Associates made a claim when they stated something they knew. Pointing to the first column on the chart from the previous day (Figure 2), Ms. Harris asked, "What do you think *claim* means based on these examples?" Student responses included: "Saying something you think is true," "When someone says they know," "Something you're pretty sure of," and "Something you're confident about." After recording students' responses, Ms. Harris asked, "So, could our working definition of *claim* be something like: A *claim* is something we say as if it is true?" The students agreed.

Next, each teacher placed "evidence" over columns 2–4 and explained that each Research Associate provided evidence for their claims. Ms. Harris asked, "What do you think *evidence* means based on these examples?" Student responses included: "Proving something is true," "When you prove it you know something is true," "When you show them something," "Do an experiment," and "Technology." Ms. Harris followed up with, "So, could evidence also be facts and information to support our thinking?" Students agreed.

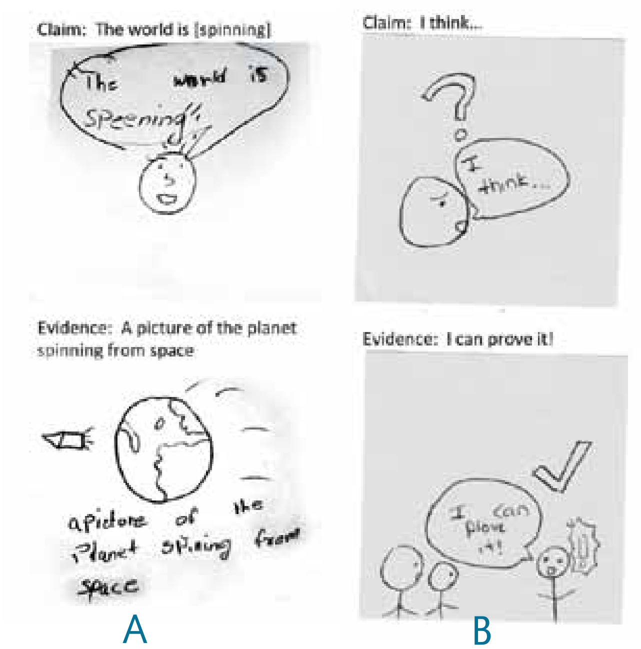
The idea that evidence can be used to challenge someone's thinking was not introduced to students and this will be addressed in future work. Also, more work is necessary to develop useful discourse tools to help teachers and students consider the meaning of truth and proof in science. For example, teachers and learners could be encouraged to substitute the phrase "not made up" for "true" in their talk (Colman 2007). Additionally, in place of the mathematical term *proof*, we promote the use of more informative descriptors of knowledge claims and explanations such as: "I am confident in this conclusion because…" "The probability of this outcome is…" "The supporting evidence for this explanation is…" "There is contradictory evidence to consider…" "This is the best explanation among the possible alternative explanations…" "This explanation is fully supported by data, within the experimental limits." *Proof* is a historical carryover from logic and mathematics and is not appropriate to describe scientific knowledge.

The teachers asked students to represent the meanings of *claim* and *evidence* in pictures of their own design (pictograms). Students worked in small groups for approximately 5–10 minutes to draw pictograms and then shared their ideas with the class. The majority of drawings depicted specific scenarios (Figure 3a) and many drawings featured a generalized representation of each concept (Figure 3b). Most students were able to express a reasonable working definition or example of these ideas.

As part of a reading lesson the same day, all the teachers asked the students, "If we look for claims and evidence in our readings this week [student-selected nonfiction texts], what do you think we'll find?" In Ms. Harris's class, Timmy predicted the author would give "A lot of evidence for the claims"; Grace thought that the reading would have "A lot of claims, but I don't know if it will have a lot of evidence"; and Madison said, "I think the authors will give a lot of evidence because authors usually talk about claims and then they have to give evidence so people trust them."

Figure 3.

(A) One group's pictograms of claim and evidence. (B) Lindsay's pictograms of claim and evidence.



Teachers projected sample texts so the class could read and analyze them together. Each class found that the authors made many claims and often provided little or no supporting evidence. Ms. Cheney asked her class, "Do you still trust the author even though he made so many claims?" Mason said he trusted the author, "Because I think as long as he gives evidence it's still proof," but Nadia said, "I don't trust the author because he made a lot of claims and so little evidence." Tommy added, "But it says 'the scientists' so I think it is real," and Katie elaborated on Tommy's comment, "I still trust him [the author] because the scientists are probably still studying about what they're writing." Finally, Lindsay explained, "I trust him…because it doesn't matter how many claims there are. It just matters that there's evidence to me."

Why do we trust an author? This deceptively simple question has profound implications for the development of a critical learner. Positioning students as researchers in this study made it possible, within two days, to lead them to discussions about knowledge claims, evidence, and trustworthiness of sources.

Day 3: Study Sources of Information

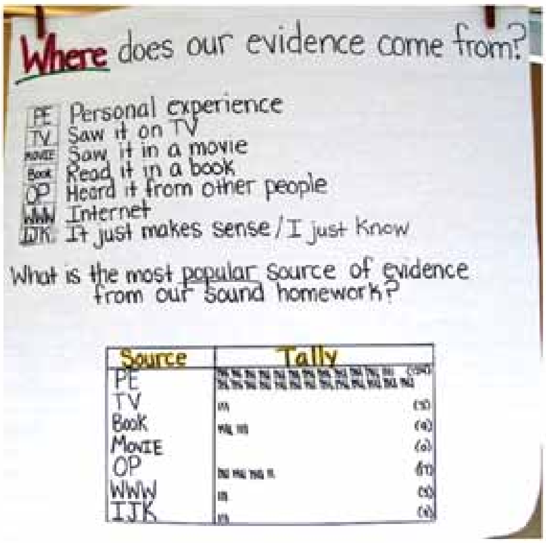
The guiding question for Day 3 was, "How can we find out what kinds of sources people use when they need evidence to support their claims?" Students generated a list of all the sources where evidence could be "found" (Figure 4, p. 48). These lists included some combination of books, movies, TV, internet, other people, personal and real-life experience, "I just know," "It just makes sense," museums, advertisements, and video games.

In practice, the teachers modified the planned guiding question to: Where do we find evidence? and Where do we get evidence? Alternate wording of these questions reinforced the idea that evidence is only an object waiting to be discovered or found (e.g., footprints, bones, a pattern of temperature) and that it is not an essential part of the process of generating knowledge. Teachers can help students learn that evidence is created only when we transform the observations we make and the measurements we take (i.e., data) by using that data to support or challenge a particular position.

Once students generated their list of sources, teachers asked students to code the interview notes from their homework on Day 1 so that the class could study the sources of evidence that their Research Associates cited. Ms. Fischer's class and Ms. Levine's class found that the most popular source of evidence to support knowledge claims about sound was real-life experience. Ms. Levine

Figure 4.

Completed chart of sources of evidence.



asked, "Why do you think so many people [Research Associates] had real-life experience as their evidence?" Cong offered, "Because sound is, like, real life!" Gabby responded, "Because we hear sound everywhere." Ms. Levine said, "We hear sounds everywhere. That's a really smart thing to say," and asked the class, "Are you experiencing sounds all the time?" The students agreed. Cong added, "Almost everything makes sound!" and the teacher agreed just before Cong pointed out, "Except for your eyebrows!" The class laughed, and several tried to move their eyebrows.

At the end of the discussion in Ms. Harris's classroom, Timmy added that the Research Associate he interviewed would believe someone based on "Who they are" and Ms. Harris asked, "So, there are some people more credible or that you trust more than others, right?" The class agreed and she explained that Timmy's comment transitioned well into the last homework assignment for the unit. Students would ask Research Associates, "How do you decide to trust the information that you read, see, or hear?"

Day 4: Make Decisions With Evidence

To begin this discussion, teachers asked their students to make a decision (agree or disagree) about a specific knowledge claim and then reflect on (a) their decision-making strategy, (b) their confidence, and (c) what types of new information could make them change their minds or become more confident.

In Ms. Levine's class and Ms. Fischer's class, students considered Li-Liang's claim: "I know dinosaurs are big." After students explained why they agreed, disagreed, or were undecided about the claim, Ms. Fischer asked, "What more could we have asked about this claim?" Shaista said, "We need to ask if all dinosaurs are big." The class agreed and Gabby added, "We need to know if all dinosaurs were big when they were born." The students agreed and Ms. Fischer asked the students whether Li-Liang was talking about full-grown dinosaurs. When many of the students responded "Yes," she challenged them, "How do you know? He didn't say 'I know full-grown dinosaurs are big,' right?" The students agreed and concluded they still had a lot of questions whose answers would influence their decisions.

On Day 4, we noticed that teachers (and then students) often conflated, agree, believe, and trust (and disagree, disbelief, and distrust). This emerged as an important practice to address with teachers and students alike. We are developing activities to help teachers and students differentiate these terms and highlight important relationships.

Day 5: Assessment Through Teaching

On the last day of the *What Is Knowledge and Evidence?* unit students were asked to create a song, skit, poem, short story, or comic that could be used to teach second-grade students what they learned so far about knowledge, claims, and evidence. Students and teachers reported enjoying this activity and every genre listed was selected and performed in class. Figure 5 is a sample of student work. A rubric that students and teachers might find to be a useful companion to this exercise is provided

Students present a teaching play about evidence.

in the NSTA Connection (modeled after Fisher and Frey 2011). This student rubric was not tested during the project, but represents the types of questions that the teachers asked as students prepared their presentations. It could be used as a tool for planning as well as evaluating student learning.

Conclusion

In this exploratory research project, we developed an instructional unit to help learners of all ages understand and apply scientific evidence within one week of instruction. By the end of the three-week project test period in each classroom, students were beginning to develop sophisticated understandings of the relationship between knowledge claims and evidence and their purpose in science. *What Is Knowledge and Evidence?* was designed as a teaching tool for teachers and students interested in building a foundation for learning and contributing to scientific knowledge. ■

Figure 5.

A student-created poem.


This week we learned something cool
If you don't want to know, you are a fool!
We learned about what we know
and say
thats called a claim everyday.
for example you could say birds are
what spiders eat
thats a claim and also a spiders
treat
Do you believe it? I don't know!
Show me evidence, 123 lets GO!
Use a book, internet or personal experience
to make me belive I am
convinced.
Maybe I agree or I will not,
I might need more evidence,
I might need alot!
If I trust the source or I
trust you, then I'll think the
claim is true!

Susan A. Kirch (susan.kirch@nyu.edu) is an associate professor of science and childhood education at New York University. Anna Stetsenko is a professor of developmental psychology and urban education at the Graduate Center, the City University of New York. Both work in New York City.

Acknowledgments

The authors would like to thank Catherine Milne and Moshe Sadofsky for thoughtful discussions. The classroom study presented here was supported by National Science Foundation grant DRL#0918533. The views expressed here are the sole responsibility of the authors and do not necessarily reflect the views of the funding agency.

References

Colman, P. 2007. A new way to look at literature: A visual model for analyzing fiction and nonfiction text. *Language Arts* 84 (3): 257–268.

Fisher, D., and N. Frey. 2011. Feed up, feedback, and feed forward: How one teacher assesses her kindergarteners during a unit on conservation. *Science and Children* 48 (9): 26–30.

McNeill, K.L., and D.M. Martin. 2011. Claims, evidence, and reasoning: Demystifying data during a unit on simple machines. *Science and Children* 48 (8): 52–56.

Norton-Meier, L., B. Hand, L. Hockenberry, and K. Wise. 2008. *Questions, claims and evidence: The important place of argument in children's science writing*. Portsmouth, NH: Heinemann.

Vygotsky, L. S. 1978. *Mind in society: The development of higher sychological processes.* Cambridge, MA: Harvard University Press.

Connecting to the Standards

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

Content Standards

Unifying Concepts and Processes

- Evidence, models, and explanation (K–12)

Standard A: Science as Inquiry

- Abilities necessary to do scientific inquiry (K–8)
- Understanding about scientific inquiry (K–8)

Standard G: History and Nature of Science

- Science as a human endeavor (K–8)

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

NSTA Connection

For a companion rubric, visit *www.nsta.org/SC1207*.