PEARSON PROFESSIONAL DEVELOPMENT

What's Your Evidence?

Engaging K-5 Students in Constructing Explanations in Science

Includes a DVD
See the framework being used in real schools!

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Scientific Explanations in the Classroom

Our interest in students' construction of scientific explanations originated from research and professional development efforts with teachers participating in school–university partnerships and the education majors who interned in their classrooms. Two of the authors, Carla Zembal-Saul and Kimber Hershberger, first began their work specifically with elementary school science. The project was known as *TESSA: Teaching Elementary School Science as Argument* (Zembal-Saul, 2009, 2007, 2005) and the goal was to support teachers in scaffolding students in the process of using talk and writing tasks to negotiate the construction of evidence-based arguments in science. The use of the term *argument* in the TESSA project was based on the adaptation of Toulmin's Argument Pattern (Toulmin, 1958) and was intended to highlight the use of claims, evidence, and justification (the basic structure of an argument) in talking and learning science. Teachers and university faculty associated with TESSA worked to develop many of the strategies that are shared in this text. The other author of this book, Katherine (Kate) McNeill, and her colleague Joseph Krajcik began their work in a similar project with middle school teachers over ten years ago (McNeill & Krajcik, 2012). More recently, Kate has begun working with elementary school teachers on how to support younger students in scientific explanation in writing and talk (McNeill, in press; McNeill & Martin, 2011).

Both projects align with the framework for scientific explanation used in this book. In order to illustrate a scientific explanation, the following examples come from Kimber Hershberger's (third author) grade 3 classroom where students were investigating simple machines. Over the course of 6 weeks, the class tested levers, inclined planes, and pulleys to develop claims about the relationship among distance moved by the load and applied force. Students had used the structure of claims supported by evidence in prior science instruction.

In the first writing sample (Figure 1.2), Karen has drawn and labeled a representation of the class demonstration in which she, one of the smallest children in the class, was able to lift the teacher by using a lever. Below her drawing, she wrote a claim that responded to the question the class was investigating: "We can use a lever to lift teacher if we put the fulcrum closer to the load." Karen documented her observations, which she used as evidence to support her claim.

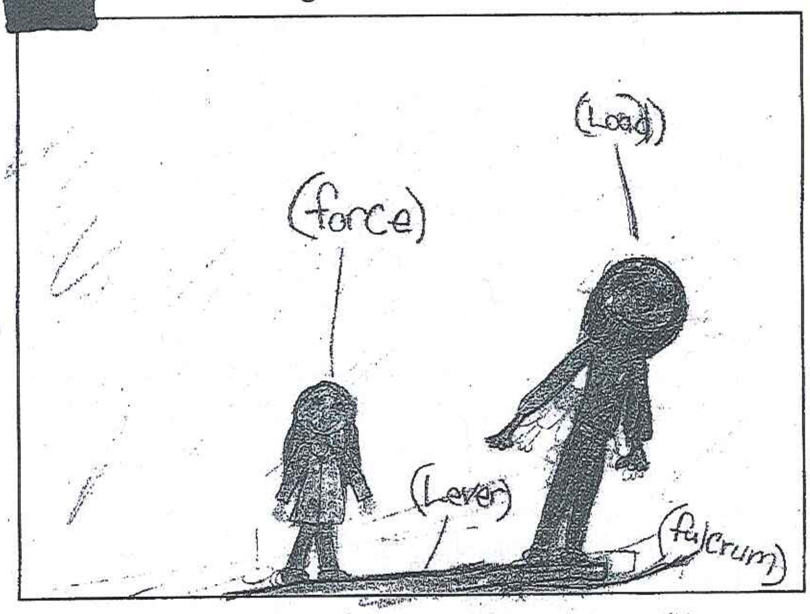
The second writing sample (Figure 1.3), also from Karen, is from a few weeks later in the unit on simple machines. For this investigation of inclined planes, the teacher designed a science notebook entry page that included the question, a data table for recording observations, and space for an explanation in which she prompted students to include claims, evidence, and scientific principles. Notice that Karen labeled the components of her explanation. It is evident in Karen's claim that she understood the relationship between reducing the force applied to lifting the load and increasing the distance of the inclined plane over which the force is applied to move the load. She wrote, "When you use inclined [plane] you use a greater

FIGURE 1.2

Karen's Explanation for How to Lift a Teacher by Using a Lever

How can you lift a teacher?

[redacted]



Explain what you learned about lifting heavy objects. (Use evidence from our experiments to support your ideas.)

We can use a lever to lift teacher if we put the fulcrum closer to the load. ⇒ When we used a bard (lever) and put a brick (fulcrum) close to the teacher (load) the student (force) was able to lift the teacher with a little effort.

distance but it takes less force to move the load." Karen also used data from her observations to compare the force needed for a straight lift (5N) to that needed to move the load to the same height using an inclined plane (3N); however, she did not include in her explanation the height to which the load was being moved (19 cm) or

FIGURE 1.3
Karen's Explanation for Inclined Planes

How do inclined planes help us to do work?

How high are we lifting the load? 19cm 7in

How much force does it take to lift the load straight up? 500g 5N

	Distance of Board	Trial #1	Trial #2	Trial #3	Trial #4	Average
B	91 cm 36 in	200g 2N	200g 2N	200g 2N	200.5g 2.5N	200g 2N
S	46 cm 18 in	300g 3N	300g 3N	300g 3N	300g 3N	300g 3N

Explanation: (Claim, Evidence and Scientific Principles)

Inclined planes help us to move a load by reducing the effort or force we use but they increase the distance.

Claim: When you use inclined you use a greater distance but it takes less force to move the load.

Evidence: Our data shows that it takes 5N to lift the load straight up and it takes 3 N of force to move the load using an inclined plane.

the distance across which the load was moved using the inclined planes (91 cm and 46 cm). She attempted to justify the connection between her claim and evidence by writing on a separate index card: "Inclined planes help us to do work by overcoming the force of gravity to move a load over a distance using less force." Although her justification was not robust, Karen did mention overcoming gravity (one of the scientific principles identified by the class).

Would it surprise you to know that Karen is a Title I student who struggled with academic writing? We selected samples of her work because they demonstrate the kinds of improvements that students are able to make in terms of writing explanations when norms of talking and writing scientifically are emphasized during science instruction. These changes can take place over short periods of time when consistently scaffolded by the teacher. For example, after discussing the components of scientific explanation as a class, Ms. Hershberger made a chart and hung it in the room for students to refer to during science talks and when writing explanations. She also emphasized the questions that students were attempting to answer through investigations by posting them in the room and including them on science notebook entry pages. These kinds of strategies are essential for supporting all students in constructing scientific explanation, especially younger students, students with linguistically diverse backgrounds, and students with special needs.

Throughout this book, we highlight strategies that can help different types of students successfully engage in constructing scientific explanations. Many of the strategies that work well for particular groups of students, such as English language learners (ELLs), are the same teaching strategies that work well for all students (Olson et al., 2009). The academic language of school science can be challenging even for native English speakers because of the specialized meanings of words (e.g., *matter, property, adapt,* etc.) and the unique features of science discourse (e.g., *the role of evidence*) (Gagnon & Abell, 2009). Consequently, we integrate our discussion of strategies for different learners throughout the book since they can be beneficial tools for all students.

Connecting Science and Literacy through Scientific Explanation

Since 2001 and the No Child Left Behind legislation, increased emphasis has been placed on helping *all* children develop literacy skills—reading, writing, speaking, and listening. In this political climate, science is not always seen as central to the education of elementary children, and often disappears from the school day to accommodate literacy instruction. However, a number of educators have argued that intentionally connecting science and literacy can enhance the learning of both (Hand, 2008; Hand & Keys, 1999). This may be something you are already attempting to do in your classroom. Inquiry-based science can provide a meaningful context for literacy activities in that it creates a motivating purpose for students to use language to negotiate meaning and figure out something new about the way the world works. Previous research suggests that inquiry-based instruction can successfully support ELLs in learning science content and language, particularly when