Sunday Cummins

There’s no doubt that students will need hands-on experiences to master the skills in science, technology, engineering, and math (STEM) that are essential for this century. As we make decisions about curriculums and school funding, we should make hands-on participation in STEM activities a priority. But we should also invite students to understand key concepts by reading, writing, and talking about the work of scientists and engineers.

Engaging with compelling texts about such professionals will help students understand the richness of scientific and engineering endeavors in real-world contexts (a major goal of the Next Generation Science Standards). An abundance of high-quality texts are available to help young people appreciate science and engineering as a set of intriguing practices that include developing theories, creating models, making inferences and predictions, talking and writing in specialized ways, and testing hypotheses through observation.

Saving the Golden Frogs

For instance, in The Case of the Vanishing Golden Frogs: A Scientific Mystery (Millbrook, 2011), author Sandra Markle describes how biologist Karen Lips investigated the drastic decrease in the numbers of Panamanian golden frogs in the mountain forests of the Fortuna Forest Reserve—and not only solved the mystery, but
also helped protect a species. Tapping her background knowledge, Lips generated hypothetical questions about why the frogs might be dying. She sought information from other sources—including colleagues in the field. A breakthrough in the mystery came when Lips sent several dead frogs to a pathologist who, using cutting-edge technology, noticed strange sacs in the frogs’ skin. When the New York Times printed an article on this discovery, scientists from around the world contacted Lips because they’d made similar observations about frogs where they lived or worked.

The result was a conference in Panama on how to save the golden frogs. Eventually, an international partnership created a refuge for this threatened species. The story makes clear how Lips and the many other scientists involved used existing knowledge and scientific approaches to develop new knowledge—and, as a result, solved an ecological problem.

It’s not enough for students to just read and enjoy texts like this one. Students can take away the “story” of such endeavors and not understand what the author is saying regarding the work of professionals like Karen Lips. In other words, it’s not enough for students to be able to say, “Dr. Lips discovered the sick frogs, and a team figured out that the frogs had a fungus growing on their skin. Then they created a refuge to save the frogs.” We want students to comprehend that in addition to tapping existing knowledge, these scientists engaged in specialized practices essential to the success of their work. That takeaway would advance students’ understanding of how the skills outlined in the new science standards play out in the real world.

We’ll increase the chances that students who read books related to STEM professions will gain such fuller understanding if we have students read with a clear purpose, talk with peers about what they’re reading, and write in response to these texts and class discussions on them. When teachers pair such activities with intriguing texts, students deepen their comprehension of science and engineering fields—and of key content and terms associated with these fields. Let’s look at one lesson series in which I implemented this approach.

“Investigating” Tarantulas—or Dolphins

Last spring, I used books connected to STEM fields to teach a series of lessons in a 5th grade classroom at a STEM school. During the 50-minute language arts block, the teacher and I employed a reading workshop model, which included a minilesson and time for students to read, talk with peers, and write responses to their readings. We introduced a set of books from Houghton Mifflin’s Scientists in the Field series. Each student selected a title they wanted to read. I chose one title, *The Tarantula Scientist* by Sy Montgomery (HMH, 2004), as an anchor text.

Before we began the lessons, I asked students to write me a letter answering the question, “What do scientists in the field do?” The majority of responses included the word study (“scientists study things,” “they study animals”). Their responses revealed that although these students seemed to understand the general work of scientists, they didn’t have the language to describe or explain the specific practices of career scientists.

On the basis of this formative assessment, we developed and taught a series of lessons focused on having students explore the term investigate while learning the content of their texts. Before beginning the lessons, I introduced an anchor chart headed with this student-friendly definition in large print:

To investigate means to examine, study, or inquire systematically in an attempt to learn the facts about something hidden, unique, or complex.

Over the course of several lessons, we added to this chart words and phrases that helped explain how...
the scientists in our books engaged in investigations. For example, the students needed help understanding what the word systematically meant. We engaged in a close reading of an excerpt from The Tarantula Scientist that described how the scientist planned to determine the number of tarantulas in a specific area of a jungle in French Guiana. This included marking off quadrants of space with bright-colored tape and then counting the tarantulas within each quadrant. As we discussed what the arachnologist was doing, we wrote additional words that surfaced during our conversation in the margins of the anchor chart near the word systematically—words like order, method, plan, and organized.

As the lessons progressed, students began to articulate more clearly—orally and in writing—the work of the professionals they were reading about. Figure 1 shows one student’s responses to the book The Dolphins of Shark Bay (HMH, 2013). Notice how her first response focuses on scientists discovering new information (uncover, looking for unknown animals or plants). In later responses, she uses specific language to describe the work of a particular scientist (makes precise calculations, goes back to the SAME family of dolphins and studies what they’re doing). Her later responses also included the purpose of this work—saving the dolphins—and the disposition of this scientist (focused, nothing will stop her).

Steps for Incorporating Texts
Following are key steps for using texts about scientists and engineers in intermediate or middle grade classrooms, as part of science instruction or during the literacy block. In the middle grades, English language arts teachers might partner with science teachers to use texts in a way that supports students’ hands-on work in the science lab.

1. Choose a focus.
The lessons just described focused on what it means for scientists or engineers to investigate. I chose this focus because of what our formative assessment revealed and as a result of studying the Next Generation Science Standards and the National Research Council’s framework for these standards.1 This framework describes scientists’ and engineers’ work as happening in three spheres of activity—investigating, evaluating, and developing explanations and solutions.

Looking over the framework document should give teachers other good ideas for a focus. Our lessons might instead have focused on what it means for scientists to evaluate something or to develop explanations and solutions.

2. Develop a text set.
Select texts clearly related to the focus you’ve chosen. As well as printed texts of various lengths, text sets can include relevant videos. (See “Resources for Creating Text Sets” on p. 72 for several book series and sources of videos). There should be at least one title for each student; some titles can be duplicates, but you want enough variety for each student to read more than one title. The value of a class-size set of texts is that students can engage with more than one text in multiple ways. Students might partner to read the same text, choose multiple texts to read independently, or join with several students to read parts of a particular text and discuss those excerpts as a group.

During one lesson, the 5th graders each interviewed a partner about how that student’s text showed scientists or engineers at work. Then all the students wrote a response telling what they learned about how their partner’s professional engaged in investigation.

You may need to modify your text set once instruction begins. As I observed individual reading conferences with students and assessed their written responses, I realized the texts from the Scientists in the Field series were too difficult for some students. So I added easier texts that were still rich in content, such as books from the Case of the Vanishing series. For one student who needed additional challenges, I found three advanced texts on the same topic—the return of the wolves to Yellowstone Park—and challenged this student to read these texts and compare their content.

3. Choose an anchor text and use it purposefully.
The anchor text serves as a launching point. Reading aloud from a good anchor text piques students’ interest and motivates them to read and respond to similar texts. When I read
aloud from *The Tarantula Scientist*, I placed the book on the document camera so students could see the up-close photographs of the tarantula. They were mesmerized as they heard about how arachnologist Sam Marshall methodically hunted for the burrows of the Goliath bird eater tarantula in the jungles of French Guiana. I picked excerpts to read aloud for particular purposes. The first excerpt, I hoped, would enthrall students with the facts about this largest spider species in the world. Later, I wanted them to hear about the multiple ways Marshall investigated these creatures—both in the jungle and later at his lab in Hiram, Ohio.

Students also closely read short excerpts from *The Tarantula Scientist*, again for specific purposes. For instance, I assigned one excerpt to help students understand and articulate the mathematical methods Marshall used to both determine the numbers of these tarantulas in a given area and collect data on the spiders’ physical features. Students also chose a page or section from their self-selected books to carefully read—and to talk and write about.

4. **Consistently refer to an anchor chart.**

An anchor chart on which you write a student-friendly definition or explanation of the focus helps students. Encouraging students to add words

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<th><strong>FIGURE 1. Excerpts from a Student’s Responses to a Text</strong></th>
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<td><strong>1st response</strong> (written before our first lesson): I’ve learned that scientists can uncover myths or prove a fact. Scientists could try to find a rare species and find some things it does, eats, etc. They could be looking for unknown animals or plants.</td>
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<td><strong>2nd response</strong> (written after the first lesson): I’ve learned a lot more now. Scientists have to have a method or a plan so they don’t over count. . . . They have to uncover mysteries or find things that are not true or something complex or hidden.</td>
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| **3rd response** I learned things about how my scientist investigates:
  - She asks other people multiple questions to learn more about these fascinating creatures.
  - She tries to find everything that has to do with a subject and then moves on in an organized way.
  - She makes precise calculations. |
| **4th response** Every [day] she goes back to the SAME family [of dolphins] and studies what they’re . . . doing—and will not miss a moment. I’ve noticed that my scientist is studying dolphins in a SAFE WAY. She will not hurt these creatures, but [wants to] make laws to save these rare, amazing creatures. |
| **5th response** [When my scientist is investigating], she stays focused and on task. If she is looking for one thing, she stays looking for that one thing. If she sees something strange or unnatural, she needs to find an explanation. She takes time to adapt to the environment or habitat. |
| **6th response** The dolphins in the story are dying rapidly. My scientist is trying to find out why, how, and if there is a way to fix that. When she thinks she’s got the answer, there is always a twist. . . . But after trial and error, the dolphins in Shark Bay are staying alive! |
and phrases that unpack the defined term nurtures their sense of agency and their identity as a member of a community that’s making meaning.

During one minilesson, I put three students’ written responses to their texts on the document camera for the class to view and consider as mentor texts. I asked students to find details, words, or phrases from these responses that we should add to our anchor chart definition. One student, for instance, said we should add the phrase “asks multiple questions.” This practice affirms students’ identities as critical thinkers—both the student who wrote the model response and the student who suggested the term to add.

5. Develop minilessons.
As I mentioned earlier, when the 5th graders’ pre-lesson written responses about what scientists do included vague language about how scientists and engineers investigate something (“they find,” “they figure out”), I created minilessons to help close these gaps in students’ understanding.

For instance, I wrote my own response to an excerpt from The Tarantula Scientist that included sketching and labeling the investigative methods Sam Marshall used. I sketched a ruler next to a segment of a tarantula’s leg, illustrating one way Marshall measured a tarantula’s growth. During the minilesson, I read this excerpt aloud and shared with students my response to it. They then created labeled sketches showing specific methods the scientist or engineer they were reading about employed to investigate phenomena.

Endless Possibilities
Because pre-assessments revealed that these particular students needed to understand what it means for scientists and engineers to investigate phenomena, I chose texts and lessons focused on that concept. But I could have highlighted many other aspects of these texts—and many other practices scientists and engineers engage in. In addition to helping students learn about STEM skills through hands-on projects, there are endless ways we can strengthen their understanding of STEM concepts through reading, conversation, and writing.

Resources for Creating Text Sets

Book Series Focused on the Work of Scientists and Engineers
The Case of the Vanishing . . . : A Scientific Mystery Series (Millbrook Press).
Sample titles (all by Sandra Markle):
- The Case of the Vanishing Golden Frogs
- The Case of the Vanishing Honeybees
- The Case of the Vanishing Little Brown Bats

America’s Animal Comeback series (Bearport Publishing).
Sample titles:
- Gray Wolves Return to Yellowstone by Meish Goldish
- Black-footed Ferrets Back from the Brink by Miriam Aronin
- California Condors: Saved by Captive Breeding by Meish Goldish

The Scientists in the Field series (HMH Books for Young Readers). This series also highlights the work of engineers.
Sample titles (all by Elizabeth Rusch):
- Eruption! Volcanoes and the Science of Saving Lives
- The Mighty Mars Rovers: The Incredible Adventures of Spirit and Opportunity

Online Sources of Texts and Videos
- Science News for Students (https://student.societyforscience.org/science_news_students)
- National Geographic STEM Education (http://education.nationalgeographic.com/education/stem-education)
- Super Science Top News (http://superscience.scholastic.com/top_news)

For more on how to connect reading and science, read the online-only article “Literacy and Science: Better Together” by Terry Shiverdecker and Jessica Fries-Gaither at www.ascd.org/el1214shiverdecker.
