BECOMING A RESPONSIVE SCIENCE TEACHER

Focusing on Student Thinking in Secondary Science

Daniel Levin, David Hammer, Andrew Elby, Janet Coffey

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Acknowledgments

This book of case studies came from the final year of a three-year research collaboration among a team of teachers and project staff entitled What Influences Teachers’ Modifications of Curriculum? (National Science Foundation ESI 0455711). As a regular part of the project, research team members visited teachers’ classes to video record, observe, and talk. In the third year of the project, the teachers recorded classes themselves (or had an assistant or student do the recording) and wrote case studies. It wasn’t our original plan to develop these materials; that idea came from a conversation with David Campbell, our wonderful program officer at NSF, and Miriam Sherin, a member of our advisory board. They helped us see an opportunity in these cases for professional development materials.

We selected from those case studies to present a broad spectrum of topics and to highlight opportunities for attending to students’ thinking. We’re very grateful to the project teachers who contributed the case studies included in this book: Sarah Henson, Janet “Izzy” Kovach, Jenny Tanner, Matt Reese and David Hovan, as well as to Terry Grant, whose class we describe in Chapter 1.

The comments presented in the facilitators’ notes come from preservice teachers in the Masters’ Certification (MCERT) program at the University of Maryland, College Park, Maryland, and from inservice teachers participating in seminars. There are too many of these people to name. Jennifer Richards helped with recording and transcribing the discussions in the MCERT classes.

We’d also like to thank all the teachers who allowed us into their classrooms over the three years of the project. The teachers participated in three different cohorts: a biology cohort and a physics cohort from Montgomery County Public Schools (MCPS), and an environmental science cohort from Baltimore County and Baltimore City. The following teachers were part of the physics cohort for at least one year, and some were in it for three years: Joseph Boettcher, John Haigh, Ken Halperin, Raymond Hodges, Joanna Mysen Cunningham, Cyril Prusko, James Schafer, Caitlin Sullivan, and Lissa Vincent. Natasha Ezerski and Leslie Van started out in the MCPS biology cohort and then switched to the physics cohort as their class schedules changed. The following teachers were in the MCPS biology cohort for at least one year: Shayda Eskandary, Nicole Hopkins, Steven Karig, Jennifer Kempf, Jennifer Kerns, Anne Merrell, Laura Pomerance, Stephen Shifflett. The following teachers were part of the Baltimore environmental science cohort: Kim Bickerstaff, Jacqueline Bilberry, Bradley Harrison, Sharon McClain, and Renee Watson. Alan Berkowitz, Director of Education at the Carey Institute of Ecosystem Studies, served...
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Anita Sanyal, Paul Hutchison, Matty Lau, and Xiaowei “Kitty” Tang worked on the project as graduate student research assistants, often taking the lead with video-recording classes and coordinating and talking with teachers. Sandy Honda, a research associate, helped out as well. Luke Conlin and Kitty Tang did most of the processing of the video that appears in this collection, adding captions and blurring or blocking out segments that include students from whom we didn’t have consent.

We thank Elaine Henry for her help throughout the project, making sure staff and teachers were paid, rooms were scheduled, and parking and travel were arranged. We’d also like to thank the people at NSTA Press who helped to guide us through the publication process: Andrew Cooke, Jennifer Horak, Claire Reinburg, and Amy America, and three anonymous reviewers, who provided useful feedback on a draft of the manuscript.

Last but not least, we thank the students (and their parents) who gave us permission to include them in these materials.
Chapter 4

The Owls and the Snakes (1)

This is the first in a pair of cases about classes on the same topic, a question developed by Izzy Kovach, one of the more experienced teachers in the project. She found an article about a “novel commensalism” wherein live, blind snakes live unharmed in screech owls’ nests, and used it to create a question for student inquiry. Izzy’s case study is in the next chapter. We start with this case, rather than Izzy’s, because it shows students discussing the question when it is first introduced. Izzy’s case study shows a class examining the evidence presented in the article to consider the various explanations that students have already proposed.

At the time of this class snippet, Sarah Henson was in her second year of classroom teaching. She attended the Masters Certification program at the University of Maryland, and received a teaching credential while teaching high school biology part-time. That program emphasized attention to student thinking, so it was an easy transition for her to join the research project when she graduated.

Sarah was particularly interested in involving her students in scientific argumentation, and, as part of that goal, in helping them learn to listen and respond to each other’s ideas. She heard about how Izzy had been using this question to do just that sort of thing, and decided to try it herself at the beginning of the school year—her first year as a full-time teacher.

The main data for this case study include the video and accompanying transcript (available at www.nsta.org/publications/press/extras/responsive.aspx). Sarah’s written case study begins after Suggestions for Reading and Viewing. We recommend that a group studying the case study start by reading only the introduction of the case to get some background information about the class; stop after reading the handout, “A Mystery Relationship.” Then read the transcript of the conversation, and/or watch at least some of the video, before continuing with the rest of Sarah’s account. This gives participants a chance to recognize and interpret the students’ thinking for themselves, before reading Sarah’s perspective.

1. This research project is described in Chapter 1.
Suggestions for Reading and Viewing

Be sure to make copies of the transcript, included in full on the website. Even if you’re watching the video, the transcript is useful for following along, for jotting notes, and for reference in conversations about the snippet with others.

Before we present the conversation that took place in Sarah’s class, we usually show participants the handout she gave the students (Figure 4.1, p. 58), and provide time for them to discuss the relationship themselves. The snippet is 25 minutes long. When we use this case in pedagogy courses, seminars, and workshops, we stop reading or watching the students’ conversation at two or three spots in order to encourage participants’ close, careful examination of student thinking:

1. **Line 56, approximately 5 minutes in, when Michelle says, “No” and laughs.**
   We usually stop here and ask participants to discuss what has happened so far and to think about the following questions: How do you think it’s going? What do you notice in students’ ideas and reasoning? Does their thinking seem scientific?

2. **Line 114, about 11 minutes in, after Robert says, “Uh, it could be part of their nest…”**
   In this section, there are occasionally disagreements about what a student means. Such disagreements are a great opportunity to ask participants if there is any other evidence to draw on to determine what a student means.

3. **Line 155, when Michelle says, “It doesn’t matter if your eyes are open.”**
   Sometimes we stop it here too, and sometimes we just show the rest of the clip. Regardless of where we stop, we ask participants to consider the “menu of possibilities” of where the teacher might go next. What ideas might be worth following up on? How might the teacher structure the next part of the conversation, or the next activity, based on the ideas she has heard?
The Case Study: A Mystery Relationship

By Sarah Henson

Background

This is a case study from my second year teaching biology at a suburban high school in Maryland. This school had been closed for 20 years, but it recently reopened to handle the overflow in student population of neighboring schools. Now it has about 1,300 students, fairly equally mixed among African American, Latino, and Caucasian students, with a minority of Asian students. Students take eight classes per semester, which meet on alternating days for 85 minutes each. The school has met AYP every year in the three since it reopened.

When I started at the school, I was teaching part-time while working on my Masters degree at the University of Maryland. In my science pedagogy classes at Maryland, I had gotten interested in looking at how I could get my students to make scientific arguments, particularly to listen to each other’s ideas and to respond to each other with scientific evidence. In one case study I wrote for my graduate program, I compared an “honors” biology class, with an “on-level” biology class during similar classroom discussions. (In my school “on-level” is a euphemism for lower academic track.)

During the discussions, I thought that the honors class was doing a lot better—certainly a lot more students were talking. When I went back and looked at both videos, however, I was surprised. Although the honors students were talking more, a lot of them were just repeating the same things, sort of “piling on” rather than considering the ideas critically. In the on-level class, fewer people were participating, but the ones who were seemed really to be listening to each other, responding with counter-arguments, and then posing their own ideas. I think that we often underestimate what on-level students can do in biology classes, and so we don’t often engage them in the same challenging scientific inquiry that we do with our honors class. I decided that I really wanted to push argumentation in all my classes in the second year, and I really wanted to see what my on-level students, in particular, could do if they were asked to argue regularly.

This is a case study of a relatively small, on-level biology class that met for 85 minutes during the last period of every other day. It was composed of 10th and 11th graders who were taking biology for the first time, except for two seniors who were repeating the semester after failing last year.
The Owls and the Snakes

This lesson was from the third class session at the very beginning of the school year. The first two class sessions were dedicated to experimental methods, so this was our first look at content specific to ecology, our first unit. I wanted students to have a first experience of scientific argumentation, and I hoped it would also get them starting to think about symbiotic relationships.

The idea for this lesson came from Izzy Kovach, another teacher in the biology group organized by the people at University of Maryland. When I started working with the group in the summer, I heard about the conversation Izzy had led with her students about the curious relationship among the “owls and snakes.” It seemed like a good way to get students to argue about a real biological question, and to draw on their experience to come up with explanations for the relationship. I decided not to introduce the vocabulary that the curriculum required (symbiosis, mutualism, commensalism, predator-prey, and parasitism) until after the students had discussed the relationship, thinking this would help them think without being tied to the particular words. I also thought this might help them associate the vocabulary with the particular relationships when they learned it afterward.

To start, I asked students to recall and share any background knowledge they had about owls and snakes. They provided information about snakes, such as what food they eat, that some are venomous, and that some are able to wrap themselves around their prey to constrict breathing. Information they provided about owls included things they eat, how much they can swivel their necks, that they are wise, and that they are nocturnal. In the course of the discussion on what the two organisms eat, students pointed out that they eat some of the same things (small rodents) and also that an owl could eat a snake. During this time, I just listened to the students’ ideas, and tried not to correct them. I really wanted to begin to create an environment in which students felt comfortable sharing their ideas without fear of being judged as right or wrong.

We also talked a little bit about relationships in general. I wanted them to think about what it meant to have a relationship in the everyday sense. I think students have relationships with family members, friends, authority figures, and pets that can help them to think about biological relationships.

Finally, I gave students the handout presenting a “mystery relationship” between screech owls and snakes [p. 58]. I told them it was a real-life situation that scientists do not fully understand, and I gave the students three tasks: extract facts from the brief written scenario, use those facts to develop
The conversation took off! So many students had so many ideas to share that it was a challenge to keep track of it all. During the class, I felt like I had a hard time following all the arguments. I just tried to keep them talking, and to get them to listen and respond to each other. After a while, they kind of ran out of steam. Michelle even said, “I’m all argued out,” and at that point I wasn’t sure what to do. So for this case study, I decided to look more carefully at the transcript for the beginning of the discussion, to see if I could untangle some of the arguments that I had a hard time following in the moment.*

*This is a good point to stop reading, watch the video, and talk about the student thinking.

The Students’ Ideas

The first idea I noticed was Diana’s, who said, “The mother might not have noticed that the snakes wouldn’t harm her eggs, so she just kind of let them stay.” Avish pointed out that they were smaller than the eggs, which is great, because I think he was supporting Diana’s idea by giving evidence that the snakes weren’t harming anyone. Robert put forth two new ideas, saying that (1) maybe the snakes eat up eggshells or bugs that come around the nest, and (2) maybe the snakes gave off heat. I thought these gave us some good ways we could go, and I asked if anybody wanted to respond. Aaron spoke up.

Aaron: It’s kind of confusing, I know what he’s talking about, so it’s 50-50. I can understand that snakes protect it, by like acting like a shield from other predators, that want to steal the egg and eat it, so that the snake was in the nest, other predators won’t go after the egg, since the snake is probably going to eat that other predator.

Sarah: Ok.

Aaron: So the owl would just leave it there and leave it alone to provide that extra shield.

Sarah: Ok, so this is like- this is kind of a new argument, Aaron, right? You think that the snakes are up there for protection. They’re protecting the eggs?
A biologist specializing in screech owls found a nest that contained both owl eggs and – of all things – snakes! While some snakes are known to eat bird eggs, these snakes were too small. They also had an unusual characteristic – they were naturally blind. As she watched the nest for a few days, the biologist noticed that the mother owl allowed the snakes to live in the nest unharmed. This seemed strange, since owls generally eat snakes or feed them to their young. The biologist had a hard time explaining this unexpected owl behavior.

Can you explain the relationship between the owl and the snakes?

Facts/Evidence:

Argument (create an argument about what you think is going on, based on the evidence you listed above):

What other information would help you solve this puzzle?
Initially, it seemed like Aaron was going to respond directly to Robert’s argument. He said, “I know what he’s talking about, so it’s 50-50.” I don’t know what he meant by “50-50,” but he said it often. Maybe it was Aaron’s form of verbal stalling, like saying “Ummm.” Maybe he was still processing what Robert said, forming his own response, or weighing the options.

But the rest of what Aaron had to say didn’t talk about Robert’s ideas at all, which makes me wonder if he’d really been listening. I think he was just making his own argument that the snakes were protectors, and wasn’t really responding to Robert. I’m glad that Aaron was engaged and eager to share his own arguments; on the other hand the rest of the class didn’t get to follow up on Robert’s argument.

There was, however, a very interesting exchange around Aaron’s idea about protection, and I remember being excited about it in the moment. I thought they were really beginning to question the legitimacy of some of the ideas.

Sarah: Wh- who agrees or disagrees? Michelle?

Michelle: I disagree because one, they’re blind. And two they’re smaller than the eggs so how are they really supposed to protect ...

Michelle’s comment was in direct response to Aaron’s argument. She clearly heard what Aaron said, and was attempting to disprove it by providing two facts (that the snakes are blind, and that they are smaller than the eggs). Perhaps because her counter-argument was so intelligible, Aaron was immediately ready to fire back with a defense. I encouraged the exchange, but tried to slow it down and track their ideas in writing on the board. This is most of what they said, with some intervening lines deleted so that it’s easier to follow:

Aaron: But since the snakes can pick up heat around other things, around the um, area, they can like detect um a prey nearby and pick it up and snap it up.

Michelle: Um, but still, they’re still small and we don’t know if they’re venomous or not, so how are they supposed to protect?

Several moments later Michelle had something else to say.

Michelle: We don’t know what they can do, like, can they like, bite? Can they constrict? What are they going to do to protect?
Aaron: They’ll constrict. But I’m not sure about the biting part but I think they can detach, detach their jaw….. and make their mouth wider. But there’s a 50-50 chance of killing themselves as well.

Again Aaron used his “50-50” phrase. Was he considering two possibilities—that the snakes can detach their jaws and either live or die in the process of doing so? It seems more likely to me that he was stalling again in order to give himself the time to weigh the implications of his previous comments and form what it was that he wanted to say.

Navarre got into the argument, suggesting that maybe if there were a lot of snakes, they could guard the nest, which I thought was great, but none of the students picked up on it. Robert reiterated his idea about the snakes eating the bugs that could do damage to the eggs, but he also responded to Michelle’s counter-argument to Aaron earlier, saying that it was irrelevant whether or not the snakes were blind, because, “there are millions of animals that are blind, but eat other animals.”

The next idea came from Bob and Navarre, who suggested that maybe the owls were just waiting for the snakes to get bigger so they could eat them. I’m not sure if they meant the parent owls would eat the snakes or the little owls would, but Robert didn’t think much of that idea.

Robert: I think if uh, the snakes were the species that got bigger, that’d probably either mean they were babies or they weren’t fully mature, so I think that that would have been said here that they weren’t fully mature snakes, you know?

This seemed pretty sensible. Robert was basically saying that these must be fully mature snakes, “otherwise that would have been said here.” Aaron also had an objection to that idea, but it took him a while to get it out. The ideas seemed to come to him all of sudden, and he started talking before I called on him.

Sarah: Aaron, what were you going to say?

Aaron: I would have to disagree on the waiting for the snakes to get big.

Sarah: Ok.

Aaron: By that time, the snake might have moved on to- by a different place, just in case this attempt didn’t sell.

Sarah: Ok.
Aaron: So, if the snake was thinking ahead, like the owls going to take its life away, so it wants to um, move on.

I’m not really sure what Aaron was saying here, I think maybe he was thinking about the snake weighing its options. I don’t know what he meant by “in case this attempt didn’t sell,” but maybe he was thinking back to Robert’s idea, and “not selling” would be like not succeeding in finding anything to eat. Then, if the snake was “thinking ahead,” it could plan to get out of there before the owl ate it. He seemed to be thinking about a conscious decision on the part of the snakes.

I made a last call for initial arguments and Robert said “Um, I don’t have a reason for it, but snakes lose their skins every several months.” Even though he did not present this information in the form of an argument that helped to explain the relationship, he thought it was important enough to bring into the discussion. I liked that at the time, and I liked it again later when I watched the tape. I also thought it was great that he said “I don’t have a reason for it,” by which I think he meant that he recognized that he was only providing a piece of information, not reasoning.

I think the importance of Robert’s comment here is twofold. First, it demonstrates an atmosphere of collective problem solving, where individuals are willing to put forth pieces of information, even if their ideas are not fully formed. This requires an environment where students feel comfortable sharing even when they don’t have a fully formed or “correct” idea. Second, this type of participation gets to the very heart of our scientific culture, which is dependent upon peer involvement, upon students like Robert who are willing to share information as well as to hear what others have to say about it.

I gave students a chance to respond to Robert’s idea, and Michelle and Navarre had new things to say. The discussion eventually came back to Robert, where he built on his initial thought.

Sarah: Ok, so we have a new factor to throw in. How might that affect things?

Robert: I don’t know yet, it’s more complicated.

Sarah: Anybody else? (Aside when student comes into the room) How-who’s got an idea? How would snakes shedding their skin play into this?

Michelle: When they shed their skin, don’t they get bigger?
Sarah: When they shed their skin, do they get bigger? Why do they shed their skin?

Navarre: That is kind of disgusting. They just start to like go, skin just crawls off them as they go…

Sarah: So I think that it has something to do with growth, that they try to- they get too big for their skin and they- it plays a role in their shedding.

Robert: It becomes part of their nest, because different animals build different...(disruption to remind the class to be respectful to others).
Uh it could be part of the nest because different animals uses different things to build their nest and it could be possible that it becomes part of the owl's nest.

Maybe just hearing his peers discuss different aspects of the idea aloud gave Robert some time to think, and helped him recognize what role this piece of information may have in the situation. He ended up suggesting that the owls would benefit from having the snakes there by using their skin to help construct (or repair) their nests. To me, this was a pretty interesting idea, because unlike all of the other ideas, it suggested that the owls were benefiting from something that the snakes produce, and not just their potential as food or for protection. It’s a sensible idea, and there are examples of this sort of thing in the natural world, for example, in the way ants protect aphids that produce “honeydew” that the ants can eat.

I continued following along with the things I had asked them to write down on the handout. The handout asked, “What other information would help you solve this puzzle?” I really wanted the students to ask questions that would help them figure out the relationship, but I found that I needed to guide them to do this. For example, Diana asked, “How many snakes were in the nest?” When I asked her why that was important to know, she responded, “Because you’d know like how many snakes are like on the eggs and stuff.” I pressed her to explain what that would make her say about the relationship, but she didn’t have a ready answer. Maybe she was thinking that if there were a lot of snakes it might support Navarre’s earlier idea that multiple snakes could work together to provide protection for the owl eggs.

Mostly, students had questions about how the owls or the biologist knew the snakes were blind (a discussion I had started as an example of a question). Robert had an interesting question that he tied to his earlier argument. He wanted to know what the snakes eat, or how they’re eating. As with Diana, I pressed him on how that was going to affect what he
thought. Again, I’ve taken out some of the intervening lines to try to capture Robert’s whole thought.

Sarah: Ok, how’s that going to- Robert, make an argument about that. How’s that going to affect what you think?

Robert: Because we’re going to find out about the snakes depending on that.

Sarah: So, do you think the first one is depending on the second one? Or do you think the second one is-

Robert: Well, I mean, it’s not for sure but it just leads … It just kind of leads …. might not be exact but you know it could … it’s just one-one reason. Because if the- if the owl built its nest around the snakes … we know that the owl wanted to be around the snakes.

Sarah: Ok.

Robert: They’re staying, and the owl let them stay, then obviously the snakes are depending on the owl.

I don’t think it’s exactly clear from Roberts’ explanation how he thought that knowing what the snakes eat would help him answer the question; he only said that it suggests that the owls “wanted to be around the snakes” and that “snakes are depending on the owl.” Earlier he’d thought the snakes might eat insects in the nest that could damage the eggs, and he might have been trying to support that idea.

I never did tell the students the “right” answer, mostly because I didn’t know myself at the time. (I hadn’t yet read the paper that Izzy found). Also, I didn’t want that to be the focus of the conversation—getting to an official answer. I wanted them to get started at having a science talk, to listen to each other, to challenge and support others’ ideas. I think they did that pretty well, and that’s what I was hoping for. After the discussion, I presented the vocabulary of biological relationships that we’re expected to teach in the curriculum (symbiosis, mutualism, commensalism, parasitism, predator-prey), and asked them to apply the terms to the ideas that had come up in the discussion.

Reflections
Like I said, I found everything kind of hard to follow during the class, although I had a sense that there were a lot of good ideas, and even some
responses to ideas and the beginnings of arguments. As I continue to teach, I hope to get better at that, keeping up with the action, hearing ideas and being able to respond on the fly. Watching later, I was all the more impressed. These were on-level students, and this was our first try at having this kind of conversation. I especially like the interaction between Aaron and Michelle about the snakes as protectors, and I think it shows the potential for productive scientific discourse among students.

At the same time, I could see that some of the students would pose new arguments instead of directly responding to the argument at-hand, like when Aaron gave his own idea instead of responding to Robert’s. That’s something to work on. Maybe Aaron and other students are so preoccupied with their own thoughts that they have trouble listening to others. I tried to display the arguments at hand at the front of the classroom, to help students focus on it, but it might help to have students talk with scrap paper at hand, to keep track of their arguments, and to write down their ideas they want to bring up later. In general, I try to encourage students to write down ideas, to give a little “wait-time” to people who might be thinking more slowly.

Additionally, is there a way, and would it be productive, to hold students responsible for actually hearing what their peers are saying? While we had previously discussed being respectful to each other, were the students aware that when one of their peers is talking, the expectation is not just that they be quiet, but also that they be listening and considering the idea being presented?

Facilitators’ Notes

Please see the general notes for facilitators in Chapter 3. Here we’ll provide specific comments and suggestions with respect to discussing the video at the recommended stopping points, the rest of the snippet, and the teacher’s case study. Our purpose here isn’t to present a thorough analysis of the snippet but to give a sense of possible topics and issues that might arise or that a facilitator might bring up.

**What Is the Nature of the Relationship Between the Owls and the Snakes?**

Often, especially if we have 90 minutes or more to spend on the case study, we will have participants discuss what they think is the nature of the relationship between the owls and the snakes before they see what students said. (Later in this chapter, we explain what researchers think, and we provide the citation to the article for people to read if interested.) Sometimes we distribute the
handout Sarah uses in the class, to pose the question; other times we have just described the question in words. We haven’t noticed a difference in the teachers’ thinking about the question, but the handout often generates discussion about instruction, even before the teachers see the video of the students talking about it. For this reason, it might make sense to wait until you show the video to provide the handout, as the focus on instruction may distract participants from their own ideas and reasoning. If you do use the handout, it might make sense to remind participants up front that they’ll have time to discuss instruction at a later point, as it relates to the student ideas in the video.

**Suggestions of Possible Relationships**

The initial suggestions of possible relationships are usually similar to what the students talk about in the case study. It usually comes up that the snakes might be eating parasites in the nest that could harm the eggs. Someone typically suggests that the snakes are somehow scaring off predators or that the owls might be keeping the snakes for the new hatchlings to eat. People usually challenge these last two ideas by asking what the snakes get out of it, which can lead to a discussion about whether or not the snakes need to get something out of it. We try to help keep track of the arguments by writing them on the board or on an easel.

The only problem we’ve encountered is when some participants have made suggestions others find laughable, such as that the owls are keeping the snakes as pets. It’s as important in workshops as it is in class that everyone feels safe and respected, so we make a point of considering the ideas seriously. And there are other reasons for taking these ideas seriously; they are not so far-fetched. For example, we’ve pointed out there are documented cases of cross-species companionship in the natural world, such as an orangutan treating a cat as a “pet.”

**Use of Vocabulary**

Especially if there are experienced biology teachers, we begin to hear some of the vocabulary that people read in textbooks. When this happens, we often write the words on the board, and ask people to explain what they mean.

The vocabulary that comes up most often are the terms *symbiosis*, *mutualism*, and *parasitism*. People sometimes remember that there can be a relationship in which one organism benefits but the other does not, and they often come up with examples, but few people know the biologists’ term *(commensalism)* unless they’ve already taught the material. There’s usually some discussion of whether there’s a distinction between *symbiosis* and *mutualism*.² When this comes up, we usually try to move participants toward consensus on what words we should use for our discussion, regardless of their “official” meaning.

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² *Symbiosis* is usually used as a general term for any kind of biological relationship among species in which at least one species benefits from the relationship by improving its reproductive fitness. *Mutualism* refers to a relationship in which both species benefit.
Sometimes this discussion of vocabulary prompts a conversation about how important the vocabulary is, or whether it’s important at all. One option is to hold off on this conversation until after watching at least part of the video, so it can be grounded in what the students actually do and say. When we have had the conversation, most people generally say that it’s not that important for thinking about relationships, but it usually also comes up that this vocabulary might be important for scientists to communicate with each other; it always comes up that the vocabulary is probably required for exams.

**Questions of Evidence**

If we go on for a while, people start to ask questions of the facilitator to try to figure out the relationship. How do the snakes get there? What happens when the eggs hatch? What do the owls eat?

Often someone points out that it’s difficult to resolve the discussion without more information. We acknowledge this limitation, but point out that it often happens in fieldwork that a journal is incomplete; perhaps the researcher who found the snakes was there to study some other aspect of screech owls, so this was a new discovery. It would be a genuine, reasonable objective for ecologists to think about what further information would help resolve the question, and so it seems like a reasonable thing for students to do in a classroom, whether or not they find “the answer.” We might also provide further “known” information, such as screech owls’ diets or the heights of the nests in the trees. Another possibility would be to introduce further data from the research paper itself (see Chapter 5).

**How Did This Relationship “Come to Be”?**

A further interesting avenue to explore is how such a relationship “came to be.” This can promote a discussion of mechanisms of evolution, and can be useful for helping nonbiologists to hear how biologists think within an evolutionary framework.

This is the kind of question a biologist would consider. Considering plausible evolutionary mechanisms is an important part of what many biologists do, and should be an important part of science learning and teaching even when the topic is not explicitly about evolution. Having this discussion with teachers can model a kind of discussion that they might have with their own students.

**What Researchers Say About the Relationship**

The title of the article is “Live Blind Snakes (Leptotyphlops dulcis) in Eastern Screech Owl (Otus asio) Nests: A Novel Commensalism.” When the “correct answer” is revealed, or participants read the article, many are often unconvinced that it is not a mutualistic relationship; they think that the authors have not provided evidence to exclude mutualism. The authors argue for commensalism...
because the snakes would be able to get food elsewhere in the ground and trees and thus are not getting any novel benefit. However, participants have argued that the snake may be receiving a benefit that the researchers are not detecting, such as protection from some subterranean predator. (The snakes usually burrow underground). Furthermore, the authors themselves suggest that since the snakes will climb trees, they might benefit temporarily when there are declining food supplies in their usual habitat.

We think that’s wonderful when participants feel entitled to argue with the scientists’ conclusions, and we like to point that out. It is something, we think, to value in students as well.

The Discussion to Line 56

Opening the Conversation

We usually stop the recording at line 56, approximately five minutes in, when Michelle says, “No” and laughs. We ask participants how they think it’s going, what they notice in students’ ideas and reasoning, and what they see in the students’ thinking that seems like the beginnings of scientific inquiry. Perhaps because there are quite a few student ideas in the first five minutes, or perhaps because we emphasize the attention to student thinking in our prompt, people frequently hear lots of ideas in these first few minutes.

Emphasizing the Substance of Students’ Ideas and Reasoning

Often, however, people also want to say something about what the teacher is doing (or not doing). In this case, people usually comment positively on Sarah’s nondirective style; some people want to point out that she reacts differently to Diana’s question (challenging her argument) than Robert’s (getting him to articulate his ideas).

We try to steer the conversation away from discussion about Sarah’s moves at this point, assuring participants that we will get back to that discussion. Instead, we try to reorient them toward focusing on the students’ ideas and reasoning. For example, if a participant says, “The teacher should have given Diana more of a chance to speak,” we might ask, “What might Diana be thinking; what might she have said?” Likewise, if a participant says, “Sarah’s doing a great job,” we will ask, “What do you hear in the students’ thinking that makes you say that?”

It also commonly happens early in the conversation that participants comment on students’ engagement. In some cases these comments are positive; participants are impressed that several students begin speaking and offer ideas quickly. In other cases, the comments are negative; they point out that only a few students are participating. We acknowledge that student engagement is an
The Owls and the Snakes (1)

important thing to pay attention to, but we emphasize that what we are doing here is focusing on the *substance of student ideas*. Teachers have a lot of practice in noticing who is engaged and who is not; they have much less practice in listening for substance.

In some workshops, participants have commented on this case (and other cases in this collection) that there is little student-student interaction; most of the exchanges are between a student and the teacher. If this comes up before we have had a chance to consider the students’ ideas, we try to hold off that discussion until we move to ideas for instruction. This is an important observation; after all, we *do* want students to talk to each other rather than only communicate through the teacher. After we have discussed the substance of students’ ideas, we come back to this issue and explore it a little. How do we understand the pattern of talk we see in this case? Is it simply that students and the teacher are unfamiliar with other possible ways of interacting in classrooms? In terms of instructional moves, how might a teacher respond instructionally if she noticed this during her class and perceived it as a problem?

**Pressing for Specificity**

Another common tendency, especially if this is the first case study they see, is that participants make general statements about how the students are doing, and we try to press them to include examples from the transcript to support what they are saying. For instance, if someone says, “I like what Robert said,” we would ask them to interpret specifically what they understand him to be saying, and what they like about it.

**Interpreting the Substance in the Students’ Thinking**

We often use this case study first because it is so rich in student ideas and reasoning. Many of these are easy to spot in this clip, and participants always have a lot to say. Our main intent in this is to cultivate close attention to what students say in these conversations, even if it is not possible from the evidence available to come to clear interpretations. (If this is the first time we are using a case study, we might remind participants: Pretend you know the students to be gifted; assume there is some wonderful meaning behind their words and we’re trying to figure out what it might be.)

As we mentioned, in the first part of the transcript, people usually pick up on Diana’s idea in line 2 that “the mother might have noticed that the snakes wouldn’t harm her eggs, so she just kind of let them stay,” and the way she argues with Sarah to defend it, such as in lines 10 and 12 where she points out that they “weren’t taking up no room” and that “they didn’t eat her eggs or anything.” Some people notice that Avish supports her argument by pointing out that the snakes are “smaller than the eggs,” implying that they’re too small to do any harm.
Robert’s ideas beginning in line 16 usually draw a lot of attention. He suggests two possibilities: (1) That the snakes eat up the eggshells or bugs and (2) that they give off heat to keep the eggs warm. People usually interpret him to be saying that the snake is helping the owl in some way by either eating up bugs or waste that could damage the eggs or babies, or providing warmth to help the eggs develop. (This is supported by his elaboration in line 65). Some people claim that his argument is stronger than Diana’s because he’s thinking about the possible benefit that the snake could provide the owl, while Diana doesn’t assume benefit to either the owl or the snakes. When we hear this, we take it as an opportunity to create discussion around the claim. Do others agree that Robert’s argument is stronger? If so, how is it stronger? Is it stronger scientifically? Or is it stronger because it seems to align with what Sarah apparently wants her students to do (come up with a symbiotic relationship in which one or the other organism benefits)?

Aaron’s comment in line 30 is interesting. In responding to Robert’s comment in line 16, he mentions that, “It’s kind of confusing. I know what he’s talking about, so it’s 50-50,” and he goes on to say that he thinks the snakes might be protecting the nest from predators. There is usually a conversation about what he means by “It’s 50-50,” and if there isn’t, we bring it up, for the simple reason that it’s a puzzling thing to say, and if a student says something puzzling it’s worth taking a bit of time to try to figure out what he means. Some people don’t think he means anything at all, and someone usually points out that he uses the same phrase in line 53 in a different context. In her case study, Sarah also suggests that this doesn’t mean anything—she says it’s a stock phrase that he often used in the class.

That has been the standard interpretation, although in one discussion, someone suggested that Aaron was reacting to Sarah. She had asked if anyone wants to respond to Robert’s argument, noting that the idea of the snakes giving off heat had already been shot down; Robert pointed out that the snakes were cold-blooded animals, and Sarah mentioned that they might not have heat to spare. The alternate interpretation is that when Aaron says “it’s 50-50,” he is saying that he agrees with one of Robert’s two ideas; he then goes on to argue in favor of what he thinks is one of Robert’s ideas (that the snake is protecting the nest from predators that will damage the eggs), although he seems to have misinterpreted Robert’s idea. We let this topic play out as it does; it is not important (and it is probably not possible) to settle on a “correct” interpretation of what Aaron really means.

Michelle, in line 36, disagrees with Aaron, saying that the snakes are blind and too small to protect the eggs. As one preservice teacher candidate interpreted it: “So the fact that they’re smaller gives her evidence to refute [Aaron’s] suggestion that this is acting like a shield from other predators.” If no one points
to Michelle’s disagreement, we bring it up and ask participants what they think of it, because it’s a good example of a student listening to and responding to another student’s idea—Sarah’s stated goal.

Often someone notices that Aaron counters in line 41 that the snakes can “pick up heat around other things” and can “detect a prey nearby and snap it up.” Michelle seems to accept that argument, although she’s not convinced that the snakes can protect. “But still,” she says in line 50, “They’re small and we don’t know if they’re venomous or not, so how are they going to protect?” Again, someone usually mentions this exchange, but we bring it up if no one does, again as examples of how students are starting to hear and respond to each other’s reasoning.

Aaron’s response in line 53 that “They’ll constrict” usually gets a laugh, perhaps because of his tone and timing (students laugh on the tape, particularly Michelle). We prompt for serious consideration—what was he thinking? Secondarily, we might ask people what they think is so funny about Aaron’s response. That people laugh might be reflective of what they understand Aaron to be thinking or why they think he states that here.

People tend to take the other part of Aaron’s response more seriously. In one workshop a teacher pointed out that he has a reasonable response to Michelle’s concern about their size when he says they can detach their jaw: “So [Aaron] didn’t agree that size matters because [he] thought that they have this ability to, like, super-detach their jaw and make their mouth wider.”

Moving From Interpretations to Ideas for Instruction

After the discussion about the exchange with Aaron and Michelle, we often open the floor for ideas for instruction that are grounded in interpretations of student thinking. We ask the participants to think not in terms of what the teacher should do or should have done, rather, what the teacher might do next, or what she might have done in response to particular student ideas. What is the “menu of possibilities”? Frequent general suggestions for what Sarah might do next include

- Let the discussion go on longer, (after all, it just started!) on the sense that it’s going well—we ask participants to articulate what’s going well about it, if they haven’t already.
- Give students the vocabulary to attach to the ideas they are generating, on the sense that the ideas they are generating connect to the target vocabulary—we ask for examples, which can generate more discussion about whether the ideas really reflect the scientific terms.
- Ask students what information they’ll need to solve the puzzle. We ask what they anticipate students might say if asked that question; some participants note that they’ve already started to ask for information.
• Keep track of the arguments and the evidence on the board, on the sense that there are many ideas in the air, or to model good practice. (Often someone suggests that Sarah seems to be doing this off-camera.)

While some participants think the discussion “just started,” others can be impatient to see “where it’s going to go,” arguing that it can’t go on through this “idea generation” phase forever. Someone usually mentions the way that Sarah seems to argue with Diana, and perhaps she might have instead opened it up to the class to say what they think about Diana’s idea. Sarah does try to get students to argue with each other, but she doesn’t seem to be encouraging them to talk to each other without going through her. It has been suggested that she might provide more “wait time” after a student speaks to try to get other students to respond, or that she might explicitly tell students that she wants them to speak to each other (perhaps doing the discussion in small groups first to give them these opportunities).

When we have distributed the handout that Sarah used in her class, instead of just describing the question to participants, there is sometimes concern that it presents the situation in terms of a single nest, and thus does not key students into thinking about how there might be a mutually beneficial relationship that was found among most members of the owl and snake species. The fact that Diana’s response does not seem to relate to an ecological relationship, but instead an anthropomorphic relationship like a person might have with a squirrel who lives in the trees of the yard, (“They’re not hurting anything so she just let them stay,”) is often given as an example of how the handout may be misleading. In this case, the argument goes, Diana is not thinking about a populationwide relationship partly because of the way the handout is written.

A nice option here is to return the focus to Diana’s response, since the comment allows a different interpretation of her thinking. Given the task she’s been asked to do, is it a reasonable response? Another option is to ask participants if there are other places where they see students considering the evolutionary benefits of the relationship. Either way, it is worth discussing possible ways to draw attention to the fact that the phenomenon is really about populations and not an isolated case. Are there other student ideas that she can draw upon to emphasize this point? One option may be for her to ask the students how they think the situation would be different if this were only observed once, versus being observed in most owl nests.

Throughout, we try to deflect evaluations of the teacher, favorable or critical, toward neutral discussions about possibilities for instruction and how they might influence student thinking. In any teaching moment there are many possibilities for how to proceed, no one of which is “correct,” and the purpose of
these conversations is to consider what those possibilities are. As well, in most of our uses of these cases, we are moving toward the participants bringing in tape from their classes, and we try to frame conversations in that way; we don’t want people to be reticent to present because they are afraid of being criticized.

The Discussion to Line 114

There are several places in this portion of the discussion we see as important for participants to consider—more important than proceeding to the rest of the video. Usually our workshops and seminars don’t go past this segment of the transcript.

Navarre and Robert’s Ideas

The first thing that people typically mention in this segment is Navarre’s question in line 58: “Can’t there be multiple snakes that guard around the nest?” A participant noted, “In line 58 [Navarre] suggests that maybe there are multiple snakes and so even though they’re small, having many of them together could be good defense like on something larger.”

Especially since the students are often responding to ideas they have heard much earlier in the discussion, it’s useful to ask participants what they think Navarre is doing here. Is he coming up with a new argument, or is he responding to something he heard earlier? The general interpretation here is that he is supporting Aaron’s “protection” argument by suggesting how the snakes could protect the nest, even though they’re small.

In line 65, Robert elaborates on his argument about bugs causing disease and probably breaking the eggs, but he also mentions the possibility that the snakes are eating the eggs. (People generally interpret him to mean eating the eggshells so they don’t deteriorate, attract bugs, and cause disease.) Furthermore, he jumps into the argument about whether or not the snakes being blind matters—pointing out that “It’s not really relevant because there are millions of animals that are blind, but eat other animals.” Participants are usually very impressed with the “relevance” argument, and with Robert in general. It’s important to try to get out in the open what participants think is so impressive about the relevance argument. While it might be obvious to some people, it’s not necessarily obvious to everyone. Especially because some participants frequently talk more than others, we want their interpretations and impressions of the value of student ideas to be as explicit as possible. This gives others opportunities to agree or disagree, which we like to encourage, especially when the interpretations of students’ ideas and their value are not necessarily clear.
“The Owl Is Just Trying to Wait for the Snakes to Get Bigger So It Can Eat Them”

Bob brings up a new argument in line 73, that “the owl is just trying to wait for the snakes to get bigger so it can eat them,” and Robert responds to this argument in line 82, by saying that if the snakes were a species that got bigger, it probably would have said that in the background information that Sarah gave them. This usually creates a lively discussion about whether or not Robert is appealing to the information that Sarah gave them as an authority in a way that is not authentic to science. (If nobody brings it up, we do.) The usual interpretation is that what Robert is doing is not really scientific. Here’s one person’s suggestion that what Robert is doing is problematic and inauthentic.

I was sort of concerned about that. I mean you would think Robert was thinking more like a student than a scientist right? He was sort of thinking like this is the way things are presented in school, like they would have told us it was baby snakes if they wanted to think about baby snakes …. So Robert says “you know what, I think that would have been said here if they weren’t fully mature snakes,” and then at 88 he says it again like “otherwise it would be said here,” so he’s really determined to stick to this handout that he’s got as like authoritative … like a worksheet that we get in science class has certain implications, it’s not merely just observations but like they would have said something else if they wanted us to think about something else.

On the other hand, occasionally someone suggests that he’s making an assumption that he thinks he’s reading someone’s research, and in that sense, he is making some assumptions that are reasonable:

If you’re reading somebody else’s research they would generally have, you know, waited or looked into and figured out whether or not the snakes were baby snakes or not and then when they were summarizing it for their article or whatever sort of whatever they wanted to present to the scientific community, they would say they were baby snakes if they were baby snakes.

There is generally agreement that Robert is appealing to the handout as the authority here. The disagreement is whether or not what he’s doing is bad or otherwise inauthentic to science.

The ways in which students perceive the authority of the teacher or the textbook is an important aspect of how they understand science, and we think this is a useful opportunity to bring issues of participants’ perspective on students’ understandings of science to the surface. So we find this disagreement productive, and if it doesn’t come up on its own, we usually bring it up, either by prompting for further views about Robert’s comment or by mentioning the ideas we’ve heard in other workshops.
Aaron also disagrees with “waiting for the snakes to get bigger,” although typically people don’t bring it up, probably because it’s hard to figure out what he’s talking about. For that reason in particular, we usually ask what he might mean by “if this attempt didn’t sell,” if nobody brings it up. One possibility is that he is anthropomorphizing the snakes and assuming that if the snake doesn’t get some benefit than it would leave before it got big. (Perhaps he’s thinking about the food snakes would get from eating predators that come around the nest—his earlier argument). It is especially important that teachers work to understand students who have difficulty making themselves understood.

“I Don’t Have a Reason for It …”

One interesting idea in this segment is when Robert mentions that he doesn’t “have a reason for it, but snakes lose their skins every several months,” after Sarah asks if there are any more ideas. We (and Sarah in her case study) think this is interesting especially because in saying “I don’t have a reason for it,” it seems that Robert understands that this is simply a fact, and not an argument based on the fact. In fact he says that he doesn’t know yet how it will affect things, because “it’s more complicated.” As Sarah points out in her case study, he does generate an argument that involves this piece of information as the conversation goes on. We point to this idea too if none of the participants mention it.

Often, however, it’s at this point that participants think that the discussion has lost some steam, and that it might be appropriate for the teacher to do something else. As one participant said:

Well, I think because they are coming up with more ideas like um, the latest idea was the shedding of the skin and stuff and seeing how that affects, like if that’s part of the mass, I don’t know. I feel like they’re at a point where they can’t defend their arguments from the beginning, now they’re trying to come up with new ideas but I feel like they should stick to like the beginning ground and try to argue that.

Not everyone always agrees that the discussion has lost steam. Some participants think that although the students don’t seem to be defending their arguments from the beginning, they may do so if given more time. While this is a nice place to move on to the “menu of possibilities” of ideas for instruction, we suggest first asking if there is agreement that the students are no longer being productive. If there is disagreement, we ask that participants be specific in what they hear the students saying that suggests they are still being productive.

Moving From Interpretations to Ideas for Instruction

Interpretations of student reasoning lead to possible ideas for instruction. One possibility is to ask Aaron what he means by “if this attempt didn’t sell.” Sarah
does respond to Aaron’s overall argument, but it’s not clear what he means by this, and it might be important to his argument. Another suggestion is that Sarah ask students to respond to each other more. For example, in line 67, when Diana asks, “Do snakes have ears?” Sarah responds to the question herself by explaining that Robert’s point above neutralizes the importance of the snakes’ abilities to detect things around them. Instead, she might ask Diana to explain why that question is important, or if she’s responding to what Robert said.

Overall, when considering what Sarah might do next, two possibilities predominate in our workshop. One is that Sarah could carefully outline the arguments that are on the table to distinguish the fully formed arguments from some of the other comments that are coming out. Another possibility is that she could move on to what she intended to do next, according to the worksheet, which is to ask the students what other questions they have, or what new information they would need to solve the puzzle.

We suggest continuing to press for other possibilities until there are no more suggestions. Some people take longer than others to speak up, and we want to capture their ideas, as well as those of the more talkative people. After all, there are other possibilities that most participants don’t even consider. For example, Sarah continuously responds to student ideas, such that the discourse pattern goes Sarah-student, Sarah-student. Sarah might instead just not say anything in some cases, for example, when Diana asks, “Do snakes have ears?” and see if a student responds. Perhaps another student will ask why that question is important.

**The Rest of the Snippet**

In most workshops and pedagogy courses, that’s as far as we get, partly because we usually spend a lot of time at the beginning of the class talking about the question itself, and partly because participants find a lot to talk about in the first two segments. One option, if you have more then one session, is to spend the first session discussing the question, (perhaps using some of the data provided in chapter 5) and then the second session on the transcript.

**Students’ Questions**

Sarah begins this snippet by asking a question of her own. We’ll discuss this later, but first we’ll address some of the students’ questions, how they might be interpreted, and how facilitators might respond to the interpretations.

In line 158, Navarre asks how the snakes can find anything for their food if they’re blind. An appropriate move here is to ask participants why they think Navarre is asking this question. He doesn’t say so, but it may be that he’s actually responding to Robert’s argument that the snakes are eating bugs in the nest, and not asking a question he had written down at the beginning of class. In that
sense his question suggests that he’s thinking of a counterargument to Robert’s. Another possible interpretation is that this was the question he had written down at the beginning of class and he was just asking this question about the snakes in general—not assuming at the time that they were eating bugs in the nest. Navarre’s question may be what prompts Rachel in line 164 to suggest that “They might eat just the nasty stuff that the owl feeds to the babies,” which Diana adds to with the suggestion that they “might smell it,” which responds to Navarre’s question.

In line 176 Bob asks, “what happened when the eggs hatched?” We want to know what participants think of this question. We think it is a wonderful question because it would answer whether the snakes are being kept for food for the babies, but no students follow up on it. Navarre, Aaron, and Michelle ask some questions, but they follow in quick succession and not much discussion ensues. In line 192 Diana asks if all snakes were blind or just those. Sarah asks Diana how that information will help her, and Diana struggles to respond. Sarah gives her some help getting started, and Diana says in line 202 that if the whole species of snakes were blind, then it would mean, “it’s common, that you just know that they’re blind. But if you just know that it was just those ones inside the nest ....” Diana doesn’t finish her thought, so it’s unclear why she thinks it’s important to know if this is something that happens with the whole species or if this is a one-time event.

Again, we’d like for participants to consider why Diana might be asking this question. One possible interpretation is that she is thinking that the snakes’ blindness has some significance if it is a specieswide characteristic, but not if it is just the snakes in the nest. This interpretation would lend some support to the participants’ argument that the handout itself was not clear enough for the students to reason in the way that Sarah wanted them to.

In line 208, Michelle asks, “How did the scientist know the snakes were blind?” A student suggests that they can tell by the eyes in lines 210–214, but a little later in the discussion Michelle disagrees, saying that, “When she said the eyes are grey, that can’t really tell you because if the snake is shedding, don’t their eyes turn like a misty blue?” There is some nice evidence here that Michelle is listening to and responding to the student’s idea, but again, it’s not clear why the students think this question is important.

Another example of this occurs in line 216, when Diana asks, “How many snakes were in the nest?” Sarah asks her why that question is important, and Diana responds that, “Because you’d know like how many snakes are like on the eggs and stuff.” Sarah tries to get Diana to explain: “What would that make you say? What would that lead you to believe if there were a lot versus a little?” and even opens it up to the rest of the class. Again, however, no one is able to make it clear how that information would help answer the question. We suggest asking participants what they think Diana was getting at. Often, the perception is that Diana and the other students don’t really know why they’re asking these
questions, especially since many of the students don’t finish their thoughts. Another possibility, however, is that Diana is considering Navarre’s earlier argument, that a large number of snakes might be protecting the nest by acting as a team.

Rachel says in line 223 that, “If there were only like three it might be a mistake in there, but if there’s like twenty then obviously that’s (inaudible).” She doesn’t finish her thought, but we would ask participants what they think she might be getting at. It’s possible that she is thinking of something like what Diana seems to be getting at in line 192. That is, she’s suggesting that the question will help them determine if this is a common relationship that has some meaning for the owls and the snakes, or if it’s just something that happened once.

Robert has some questions that do appear to give him information that he would need to determine the relationship between the owls and snakes. He asks, in lines 235–237, “What do the snakes eat? How are they eating? ... and uh, who’s their prey?” When Sarah asks him how that’s going to affect what he thinks, he eventually says that it would tell us that the snakes are depending on the owl in some way. The usual interpretation is that he is expecting that if the snakes eat something that is found in the owl’s nest (like eggshells, insects, or things the mother owl feeds the babies—all things that were mentioned earlier), then he could understand how the relationship benefits the snake. If no one brings up Robert’s question, we would, because we think it demonstrates a good example of a student connecting his question to an earlier argument.

What Happened at the End of the Class and the Menu of Possibilities

Regardless of how much of the video we show, participants want to know what happens next. We tell them what Sarah did: She introduced the vocabulary that is called for by the curriculum and discussed examples with the students about what kinds of relationships were implied by their arguments. Considering what Sarah did next can lead to disagreements about whether or not this is what she should have done, or whether it makes more sense to do something different; for example, (if participants know of the data from the paper) possibly giving the students the data now. While considering “the menu of possibilities” for instructional responses is important, we try, again, to make sure the conversation is grounded in the ideas that the students bring up.

Discussing Sarah’s Case Study

Structuring the Discussion

We have always shown and talked about the video, at least through line 114, before people read Sarah’s case study. Showing the video first, we think, helps
The case seem more real. It also gives workshop participants the chance to form their own ideas about what is happening. Often their ideas align with Sarah’s.

We have approached the analysis of Sarah’s case study in two ways. One way is to have participants discuss the case study in a subsequent class or seminar. During this conversation, we prompt participants to pay attention to the teachers’ interpretations in discussing the case. Rather than focus first on what she does as the teacher, we ask participants to focus on what she sees and hears. What are the interpretations she makes that motivate her to respond? How do her responses fit with her interpretations?

There is not always time to have such a conversation, however. Another option is to have participants, especially if they are students in a methods class, read the case study and transcript and prepare a written analysis focusing on (1) student ideas they noticed that they think are particularly important, (2) how Sarah interpreted the student ideas that she heard, (3) places where they disagree with Sarah’s interpretations, and (4) their own “menu of possibilities” for how Sarah might have responded to particular student ideas, or where she might go next. Although much of this analysis (particularly parts 1 and 4) might have happened in the conversation during the video, doing this assignment gives each participant an individual opportunity to do some analysis. Thus, if a few participants have dominated the conversation, others now have an opportunity to express their thoughts. A short follow-up discussion, after participants have read and commented on the case study, can then bring in some of the interpretations or ideas for instruction that were not discussed the first time around, especially if there was not time to watch the entire class on video.

“My Students Would Never Do This”

Often, people want to hear more about the background of the class. What expectations for student and teacher talk have been established? Have they had these kinds of conversations before? For many, it is surprising that “on-level” students are so well behaved, are attentive to each others’ ideas, and seem comfortable arguing with each other. Often people feel that this sort of conversation could not happen in their own classes, and they want to know what was special about these circumstances. We try to deflect the perception that this was anomalous, mostly by simply telling participants that we have several examples of these kinds of productive conversations from high school and middle school classrooms. We argue that secondary students rarely have the opportunity to engage in these kinds of conversations, and it is important to give them such opportunities. When these conversations do occur, it is important to listen to the students and take their ideas seriously.
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No one would find it strange to see a geologist poring at length over a single rock, or an entomologist over a moth, or a botanist over a leaf. Examining a specimen closely can help scientists develop new understandings. That's just what we hope to achieve in poring over moments of student thinking. —from *Becoming a Responsive Science Teacher*

When you begin a new unit and discover that some students don’t understand an important concept, do you just correct the error and give them the answer? If so, you run the risk that students will memorize what you say without changing their core misconceptions. This thoughtful book explores how to identify such moments through “responsive listening” and turn them into opportunities to build students’ science literacy.

In the process, you just may transform your approach to classroom teaching. To help you make the shift, *Becoming a Responsive Science Teacher* offers

- a philosophical framework for understanding the beginnings of scientific thinking in high school students.
- five real-life case studies, four of which are captured on videos—and accompanying transcripts—available on the NSTA website.
- suggestions for how to use the case studies to practice recognizing, interpreting, and responding to the vital nuances of your own students’ thinking in real time.
- advice on next steps, including how to overcome systemic impediments and maintain your focus on student thinking.

*Becoming a Responsive Science Teacher* is ideal for teacher educators as well as current and preservice teachers. The book holds out the promise that when you consciously strive to help students work through their ideas about science, the result can be more effective instruction from you—and much deeper understanding for your students.