Teaching Science to English Language Learners

Building on Students' Strengths

Ann S. Rosebery and Beth Warren, editors

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About This Book

The essays in this book are written by researchers dedicated to improving science education for English language learners. To make the essays as accessible and useful as possible, we have grounded them in two ways. First, case studies from actual classrooms bring the research to life and describe instances of teaching and learning. Second, reflections by teachers, entitled "A Teacher's Perspective," extend the ideas discussed in the essays by offering a classroom perspective.

The essays are organized from a classroom teacher's point of view. "Part I, Teaching From Students' Strengths," begins in the classroom with a discussion of intellectual strengths that students bring to school from their everyday lives. It is composed of four essays that address the educational benefits of using students' intellectual strengths as the foundation for science teaching and learning. Part II, "Teaching Academic Language," moves to a discussion of academic language. It is composed of two essays that focus on issues related to learning to talk, read, and write science in school. Part III, "Learning More," offers additional information on important issues for interested practitioners. It includes four essays that summarize current perspectives on culture, second-language acquisition, instructional programs, and culturally responsive classrooms for English language learners. Part IV, "Teaching All Students," contains two essays that urge educators to think deeply and critically about the meanings and roles of equity and diversity in teaching science to English language learners.

The essays in this volume can be read in any order. For example, Walter Secada's essay on equity in science education is located in Part IV, but some readers may wish to begin with it because of the big-picture view it provides. We hope that, taken as a whole, the ideas in this volume will shed light on some possible answers to questions readers are asking about teaching science to English language learners.

Acknowledgments

This volume was developed by the staff of the Chèche Konnen Center at TERC in Cambridge, Massachusetts. The Chèche Konnen Center is dedicated to improving opportunities to learn in science for children from communities historically underrepresented in the sciences. It conducts research on learning and teaching in urban classrooms, and on teacher inquiry as a form of professional development. (For more information, visit our website at: *http://chechekonnen.terc.edu*.)

The editors wish to thank all the contributors to this volume, who include Chèche Konnen Center staff as well as educational professionals from other institutions. The list of contributors can be found at the end of the volume. We are especially appreciative of Lori Likis's thoughtful contributions as developmental editor. We also thank Dee Goldberg of the Spring Branch (Texas) Independent School District and Gail Paulin of the Tucson (Arizona) Unified School District and their colleagues for providing classroom examples. Authors Fred Genesee and Donna Christian wish to thank Beverly Boyson, Andrea K. Ceppi, Virginia Collier, Jana Echevarria, Claude Goldenberg, Elizabeth Howard, Jo-Anne Lau-Smith, William Saunders, Deborah J. Short, Wayne P. Thomas, and Lois Yamauchi for their contributions. Most importantly, the editors wish to thank the many teachers and students who were involved in the research reported in this volume.

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Ann S. Rosebery
Beth Warren

Introduction

Can students learn science before they are proficient in English? Do students need to master basic skills before they can engage in scientific inquiry? Is concentrating on the specialized vocabulary of science the best way to help English language learners learn science? Can a student's cultural background interfere with or support learning in science?

This book addresses these and other questions that are frequently asked by educators teaching science to English language learners. It offers a variety of voices in response. Through education-related research, classroom case studies, and the perspectives of classroom teachers, this volume offers valuable information for teachers who wish to reflect on, experiment with, and adapt their instructional practice to teach science to English language learners. Its aim is to support educators in their efforts to see linguistic and cultural diversity as a resource—rather than an obstacle—in the science classroom.

THE DILEMMAS EDUCATORS FACE

By 2030, children from homes in which a first language other than English is spoken will constitute approximately 40% of the school-age population in the United States (Thomas and Collier 2002). This shift is expected to happen in 15 states—including Arizona, California, Florida, Texas, and New York—by 2015 (Hochschild and Scovronick 2003). It has already taken place in several large urban school systems such as New York City, Miami, and Los Angeles, where half of the children in the public schools are immigrants or from immigrant families.

At the same time, schools in the United States are struggling to provide children from historically underserved populations with high-quality opportunities to learn in science and mathematics (NSF 2006). These children have limited access to

- rigorous, comprehensive science and mathematics programs, K–12;
- well-prepared, enthusiastic science and mathematics teachers; and,
- basic, up-to-date facilities, equipment, and resources, such as computers, laboratories, and textbooks.

Perhaps even more consequentially, children from historically underserved populations are judged as having low ability in science and mathematics at much higher rates than are children from white, middle-income families. One result is that science and mathematics programs in the schools of children from historically underserved populations tend to put less emphasis on inquiry, problem solving, and active involvement and more emphasis on basic skills than do the science and mathematics programs in schools that serve middle-income children (August and Hakuta 1997; Garcia 2001; Oakes 1990; Oakes et al. 1990).

Teaching English language learners is challenging because, by definition, teachers are often interacting with students from linguistic and cultural backgrounds distant from their own. Many of us who speak English as a first language tend not to think about the dynamics that language and culture play in our daily lives. We live relatively unaware of how these dimensions figure into our daily experience. We may come closest to recognizing their potential impact on our lives when, for example, we struggle to read a book written in an unfamiliar style or cannot understand a doctor's explanation because it includes technical language with which we are unfamiliar.

Sometimes the distance between a teacher's experience and that of her students may obscure her sense of her students as thinkers and learners and inadvertently work against her best intentions to teach them. In an account of her experiences learning to cross cultural fault lines as the sole American teacher at a preschool serving Haitian immigrant children, Cindy Ballenger (1999, p. 3) expressed this challenge well.

> I began with these children expecting deficits, not because I believed they or their background were deficient—I was definitely against such a view—but because I did not know how to see their strengths.

Teachers routinely face this dilemma: how to understand a child who uses language, whether English or another language, in ways that do not make sense to the teacher, that seem off topic, confusing, or somehow academically deficient. Teachers may find that they ask themselves questions like: Does the child understand what I am asking her to do? Is the child being rude or making a joke? Why is the child telling me a story about a bicycle hitting a pedestrian when I asked for an explanation of the pattern of speed of a toy car rolling down a ramp? What does the story have to do with constantly accelerating motion?

A premise of this book is that to teach science effectively to English language learners, teachers must learn to see the deep connections between their students' language and cultural practices and the language and cultural practices of knowledge making in the sciences. Such insights form the foundation for effective teaching practices.

This book offers examples of classroom-based research that shed light on the depth of the connections between children's diverse language and

Deep connections exist between students' language and cultural practices and knowledge making in science.

cultural repertoires and those of the sciences, and we share examples of classroom practices in science that are designed to build directly on these connections.

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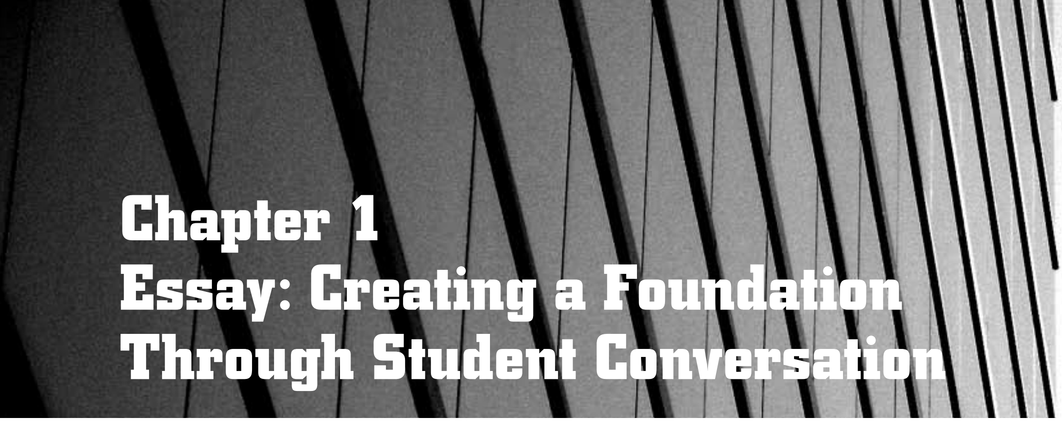
About the Editors

Ann S. Rosebery is a codirector of the Chèche Konnen Center at TERC in Cambridge, Massachusetts. The mission of the center is to improve science teaching and learning for elementary and middle school children from communities historically placed at risk. Rosebery's principal interests are identifying the intellectual, linguistic, and experiential resources that children from those communities bring to learning science and the related issues of teacher professional development. She conducts classroom-based research in close collaboration with teachers and has worked with school districts nationwide to establish programs of professional development that help teachers teach to the intellectual strengths of all children, with a special focus on those who are learning English.

Her work has been funded by the National Science Foundation, the U.S. Department of Education, the Ford Foundation, and the Spencer Foundation. She has taught elementary and middle school students as well as graduate level courses in psychology and education. She has a BA in psychology and education from Smith College, an MS in language and literacy from the University of Pennsylvania, and an EdD in human development from Harvard University Graduate School of Education. She is the author of numerous articles and books, including a video series, for both practitioner and scholarly audiences.

Beth Warren is also codirector of the Chèche Konnen Center, TERC, in Cambridge, Massachusetts, where she does research on learning and teaching as processes of intercultural navigation within and across academic literacies. For the past 20 years, in close collaboration with teachers and researchers at Chèche Konnen, she has worked at a) documenting the rich, varied sense-making practices that children from communities historically placed at risk use to understand scientific phenomena and how those practices connect in generative ways with the practices valued in scientific and other academic disciplines; b) designing innovative classroom practices that support children in deep and expansive meaning making in the sciences; and c) developing and studying forms of teacher professional inquiry that focus on learning to teach to the intellectual strengths of all children.

Over the years, she and her colleagues have received many grants from the National Science Foundation, the Spencer Foundation, the Ford Foundation, and the U.S. Department of Education, and have collaborated with several national research centers. The resulting work has been published in various journals and books. Warren has a BA in French language and literature from Wesleyan University, an EdM in reading and an EdD in human development from Harvard Graduate School of Education.



Chapter 1
Essay: Creating a Foundation Through Student Conversation

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In this essay, we discuss a pedagogical practice called science talks. *Science talks allow students to use their diverse language practices and life experience to understand scientific phenomena and allow teachers to see new connections between students' ideas and those of science. Science talks are a time when all students can think together about scientific ideas and practices and when all teachers can listen carefully to their students' comments and conversations with one another.*

Language and Cultural Differences in the Classroom

At one time or another, many teachers of English language learners may have had thoughts similar to the following, expressed by a bilingual teacher:

> Our kids don't have the cognitive skills. They are not developed as much. They don't know how to summarize, analyze. I am not saying they don't have the ability. They are coming from a different socioeconomic background. It is not realistic for us to have the same expectations.

Teachers can be overwhelmed and frustrated by the distance that stands between the life experiences of their students and the expectations of school. The ways students and their families live, their customs and styles of communicating, may seem wholly unfamiliar. A teacher may be confused by how a given student communicates ideas, experiences, and intentions; shows interest and respect; shows a lack of understanding; or shows that she or he is "smart."

The diversity in the background and life experience of students actually represents a source of considerable intellectual and pedagogical power for both teachers and students—rather than an obstacle that must be overcome.

When so much is unfamiliar, teachers may not know how to help students connect the science curriculum to their lives outside of school. Many English language learners are from low-income families with little formal education. They may not read or write in their first language, let alone in English. Often, these students function below grade level and fail state-mandated achievement tests. Although students' language and cultural differences present teachers with instructional challenges, it is important to remember that these challenges are not the result of intellectual deficits in students. The diversity in the background and life experience of students represents a source of considerable intellectual and pedagogical power for both teachers and students—rather than an obstacle that must be overcome. When teachers know how to recognize and build on this diversity, it can be an asset in any classroom and particularly in the science classroom.

Typical Structure of Classroom Talk

An important first step for teachers in learning to build on students' diversity is to examine how talk in the classroom is typically structured and the effect this has on students' participation and thinking. Classroom research (Cazden 1988) shows that the most common form of talk among teachers and students across all grade levels and subjects is a three-part sequence in which

- the teacher asks a student a question,
- the student responds, and
- the teacher evaluates what the student has said before calling on the next student.

This sequence is sometimes referred to as "teacher initiation-student response-teacher evaluation," or IRE for short. IRE has several unique characteristics that mark it as classroom talk rather than authentic discussion. One characteristic is that the teacher does not actually need the information she has requested. Instead, she is checking to see if the student knows it. Another characteristic is that the interaction is entirely controlled by the teacher. She determines the topic, its development, what counts as relevant, and who gets to speak.

The following is an example of IRE:

Teacher: Sarah, what is the temperature?

Sarah: 63° Fahrenheit.

Teacher: Right.

This simple example demonstrates the characteristics of IRE. If the teacher's request for information were a genuine one, she might have ended this sequence with "Thank you," or "Oh, that's warmer than I thought," rather than "Right."

The IRE pattern is so strong that, when students want to change it, they have to "misbehave." They may call out to get the floor, challenge what the teacher has said to change the way the topic is developing, or make a joke to question how a response has been evaluated. Because of its tight structure, IRE prevents the exchange of ideas among students and inhibits them from building meaning together. (For more on IRE, see Cazden 1988.)

The prevalence of IRE as an instructional approach is particularly problematic in science education. Cazden reports that IRE is used more often during the study of mathematics and science than it is in social studies or literature—and more often by teachers who work with low-income students and students learning English as a second language than by teachers who work with middle-class students. The picture that can be pieced together, then, is that low-income students and English language learners have fewer opportunities to think and talk in extended ways about their ideas in science than middle-class students, a situation certainly not optimal for learning. To offset this situation, teachers first need to become aware of their use of interactional patterns like IRE and then make deliberate efforts to incorporate alternative patterns into their lessons, particularly in science and mathematics.

Other Talk Styles

Even when teachers do not use IRE, authentic exchange of ideas rarely takes place in the science classroom. Jay Lemke, a former physicist interested in science education, recorded and analyzed conversations in junior high and high school science classrooms. He found that most of the talk consisted of impersonal, objective, expository language that lacked emotional content. Teachers and students rarely used slang, figurative or metaphorical language, hyperbole or exaggeration. They almost never engaged in arguments, told stories or jokes, or used other forms of humor (Lemke 1990). These findings confirm the standard view of scientific talk—as well as most other scientific practices—as objective, impersonal, expository, and devoid of emotion.

Objectivity and emotional detachment are strongly associated with Western science and are embodied in formal, academic ways of talking and writing. Most middle-class American students are relatively fluent in this way of talking because they learn it at their parents' knees. (See Hudicourt-Barnes and Ballenger, p. 21, for more discussion.) Children from families with little formal schooling, as well as many English language learners, are typically less familiar with this kind of academic talk. They learn to express their ideas in other language styles. Before they learn academic English, these children often express what they know through stories of personal experience. Although these stories may contain significant scientific content, teachers often hear them as unscientific because of their storylike nature. Learning academic forms of English is one of the major challenges that English language learners face; on average it takes five to ten years to learn this form of language (Cummins 2000). (See essays by Gee, p. 57, by Snow, p. 71, and by Bialystok, p. 107, for more on issues related to learning academic English.)

English language learners are typically less familiar with academic talk. They often express what they know through stories of personal experience that include significant scientific content.

The assumption that scientific discourse is essentially objective is misleading, however. It hides the important role that passion plays in the work of scientists (Wolpert and Richards 1997). Scientists are deeply tied to their research. Many have been fascinated by scientific phenomena since childhood—Albert Einstein, Richard Feynman, Robert Goddard, Barbara McClintock, and E. O. Wilson among them. In the words of mathematical biologist Evelyn Fox Keller, "Good science cannot proceed without a deep emotional investment on the part of the scientist. It is that emotional investment that provides the motivational force for the endless hours of intense, often grueling labor" (Keller 1983, p. 198). The same is true of children pursuing science. To learn a discipline such as physics or biology, a child must care about understanding it. In particular, she or he must care deeply enough to be willing to puzzle through the sometimes complex and unfamiliar relationships that hold between scientific ideas and ways of thinking and her or his own experiences in the world and ways of accounting for them. One way to encourage children's passion for science is to set aside a time when they are able to use their own words to express and think through their ideas about the world.

Science Talk

One form of discussion that has been shown effective in supporting science learning is called *science talk* (Ballenger 2003; Gallas 1995; Rosebery and Hudicourt-Barnes 2006). Science talk simultaneously builds students' conceptual understanding and sustains their passion for science. Science talks are conversations in which students discuss their ideas and questions about the natural world with one another openly and respectfully. Science talks are not about right or wrong answers. They are a time for students

- to think about how an idea or perspective fits into their understanding of the world,
- to identify and build connections between what they already know and what they are being asked to learn,
- to raise and explore questions, and
- to learn from one another.

In science talks, students engage with many intellectual aspects of science and grapple with important scientific ideas. They learn how to present and explain their ideas to others. They learn what counts as evidence in a given situation. As they participate, they learn how to present a point of view with clarity, make evidence-based arguments, answer challenging questions persuasively, revise their thinking in the face of counterevidence, clarify their own thinking by talking to others, and raise new questions. Equally important, they have the opportunity to feel smart and to practice their developing English skills for academic purposes. Because science talks are a time for students to think out loud together, every student can have a voice in the curriculum. Even students who struggle with reading, writing, mathematics, or English have ideas and questions about the natural world. Many teachers are surprised to see these students emerge as intellectual leaders during science talks.

Science talks give every student a voice in the curriculum.

Science talks are typically organized around students' questions. Most teachers use science talks in conjunction with their existing science programs, returning to questions that students have asked during the week, such as Where do seeds come from? Do pumpkins float? What does it mean to say we "waste" water in light of the water cycle? and Do plants grow everyday? Some teachers let their students choose the question for science talk; others choose a question they think will be most productive in pushing students' learning forward.

Teachers often set aside a block of time once a week for science talks. Teachers generally find that as their students become increasingly knowledgeable about a scientific phenomenon, such as plant growth and development or the water cycle, students want—and profitably use—more time to think with one another. Thus, what starts out as a 20-minute science-talk time block easily grows to 30 or 45 minutes. Interestingly, we have found that the length of a science talk is not related to the students' age: Students in first and second grade can engage in serious scientific discussion for 45 minutes or more (Warren et al. 2005). For an example of extended scientific discussion among first and second graders, see Chapter 9, "Case Study: Vocabulary," p. 85.

Teachers take on a different role during science talks. Instead of teaching new information, their primary job is to listen to their students' ideas. Some teachers are most comfortable combining the role of listening with the role of facilitating. They may occasionally re-voice what they think students are saying, articulating important connections they see among students' ideas or between a student's perspective and that of science. (Teachers who re-voice must follow up with the original speaker to find out if the re-voicing represented the student's intended meaning. If it did not, the student should be given a chance to clarify her or his meaning.) In addition to re-voicing, teachers may ask students to elaborate on their ideas when they think it is needed. On the other hand, some teachers feel that, to really hear their students, they cannot do anything but listen and take notes during science talk. These teachers teach their students to manage the conversation for themselves with techniques such as having the last speaker call on the next speaker and teaching students to ask one another for clarification and elaboration when necessary.

Regardless of the role a teacher finds most comfortable, her or his goal in science talk is to listen to students' ideas and develop a reflective stance toward them. Because science talks make students' thinking public, they are an opportunity for teachers to identify the intellectual stuff that is available for teaching and learning. By reflecting on students' ideas in relation to the material they are expected to teach, teachers create a foundation for designing lessons that are responsive to students' thinking and responsible to the curriculum. (See "Getting Started With Science Talks", p. 10, for suggestions on ways to get started. For more information on science talks, see Gallas 1995 and Rosebery and Hudicourt-Barnes 2006.)

Case Study: Do Plants Grow Every Day?

This case study focuses on an event that takes place in a third-grade classroom in a two-way bilingual program in Cambridge, Massachusetts. (See Genesee and Christian, p. 129, for more information on two-way bilingual programs.) Half the students speak Spanish as a first language and are learning English; the other half speak English as a first language and are learning Spanish. The students are studying plant growth and development using Plant Growth and Development by the National Science Resources Center (NSRC 1991). They have been collecting and recording data on plant growth for several weeks. During the investigation, their teacher, Ms. Pertuz, listed their questions on chart paper. On this day, Ms. Pertuz has decided to try a new kind of discussion called science talks, for the first time. The class is considering the following question posed by one student: "Do plants grow every day?"

Although almost all students in the class participate in this science talk, we focus on two students, Elena and Serena. Elena is from a working-class family; her parents have little formal schooling. Her mother is from Mexico, and the family speaks both Spanish and English at home. She is repeating third grade, and Ms. Pertuz is concerned about her progress. Elena rarely speaks during academic lessons and until now has been almost silent in science. By contrast, Serena is seen as a strong student. Although her parents, too, are immigrants to the United States, they are from highly educated families. Both her father and mother hold advanced academic degrees. Serena is fluent in both Spanish and English, including academic Spanish and English, and participates frequently in the classroom.

Desiree begins the science talk by reading her question aloud, "Do plants grow every day?" Serena responds by claiming that plants do grow every day but "our eyes can't see it." She explains that the measurement tools they have been using may not be able to detect the small increments that the plants grow each day ("Our rulers can't be perfect."). That notwithstanding, she invokes the charts and graphs the children have been keeping as evidence that plants grow every day. For Serena, the charts and graphs are proof of daily growth.

Juana, a student who rarely participates, then asks, "How come we can't see them grow? And how come we can't see us grow?" In contrast to Serena's focus on measurements and graphs, Juana focuses on the plant. She wants to see it grow and see herself grow. Then Elena says, "I don't think we could see them grow, but I think they could feel theirselves grow. Sometimes we can feel ourselves grow because my feet grow so fast cuz this little crinkly thing is always bothering my feet. That means it's starting to grow. It's starting to stretch out."

Prompted by Juana, Elena is thinking about the moment-to-moment process of growth. How would growth feel to a plant? As she describes the crinkly thing in her feet, she wriggles her nose and she makes her voice high and throaty. It is as if she is trying to re-experience for herself and dramatize for others the crinkly feeling of growth by recreating it, in her imagination and physically in her intonation and body movements. Unlike Serena who was observing the plant from the outside, Elena is thinking and talking about growth from a perspective inside her own body, aligning herself with the plant. In her imagination, she is with the plant, not on the growth chart as Serena is.

RECOGNIZING STUDENT CONTRIBUTIONS

Many teachers would be impressed by Serena's use of graphs and charts to find and justify an answer to Desiree's question. Serena seeks to represent the plant's growth through objective measurement, from a perspective outside the plant. Her approach highlights the value of recorded measurements and data. Learning to make, read, interpret, and use charts and graphs are key to acquiring a scientific perspective. Serena's response can rightly be heard as scientific, perhaps even as "the answer." In another situation, it might end the discussion. There is much about growth, however, that this perspective leaves untouched.

Elena's approach, on the other hand, invites her classmates and the teacher to wonder about growth as it takes place in real time. By imagining herself inside the plant and trying to feel what her own growth is like, Elena positions them all to wonder what exactly is going on as something grows. She invites them to think with her about growth as three- rather than two-dimensional, as something that results in filling socks and shoes as well as in getting taller. She also prompts them to think about when growth happens and what its pattern might be. Does it happen in constant little increments or is it more punctuated, less predictable?

Many renowned scientists have imagined the world at other levels as Elena is doing, especially when working at the edges of their understanding. (See Ogonowski, p. 31, for a discussion of the role of imagination in science.) The Nobel Prize–winning biologist Barbara McClintock said the following about her work with the chromosomes of Neurospora, a red bread mold: "When I was really working with them I wasn't outside, I was down there. I was part of the system. I was right down there with them and everything got big. I even was able to see the internal parts of the chromosomes—actually everything was there. It surprised me because I actually felt as if I was right down there and these were my friends" (Keller 1983, p. 117). Elena's embodied, imagined way of thinking about plant growth echoes McClintock's experience and words, experience that was crucial to the trail-blazing science McClintock conducted.

By imagining growth in a sensory way, Elena makes accessible otherwise unexamined scientific aspects of the plant's growth process, such as what might be happening inside the plant as it grows. It changes the relationship that she and her classmates take toward what they know. Her imaginative, embodied approach makes it possible for other children to question and examine knowledge they might otherwise ignore. Not only does their discussion and probing become more specific and grounded but also more children—children who are typically quiet in science like Elena and Juana—participate. From here, the children go on to consider and imagine other aspects of a plant's life from a biological perspective. They consider, for example, how the sun gets inside the leaves. (See Ogonowski, p. 31, for further detail on the role of imagination in science learning.) Elena's approach proves to be an important perspective with which the other children, including Serena, can engage. Similar to practicing scientists, these children, led by Elena, use their imagination as a powerful scientific tool to enter a natural phenomenon to better understand it.

Because Ms. Pertuz wants to hear the students' ideas—particularly the ideas of students like Elena and Juana, who to this point have not participated in science—she allows the conversation to continue past what might otherwise have been seen as "the answer" provided by Serena. Because Ms. Pertuz is prepared to listen carefully for connections between her own knowledge of plant growth and the children's ideas, she recognizes Elena's contribution to this discussion, which she otherwise might have dismissed. Ms. Pertuz realizes that the contributions of both Elena and Serena play important roles in deepening the class's thinking.

WHAT THE TEACHER LEARNED

Ms. Pertuz, like her students, benefits from the science talk. First, she achieves a new perspective on several of her students. To her surprise, she hears from many quiet students and discovers that, despite their silence, their minds are going a mile a minute and they have much to contribute to the discussion. She also sees students like Elena and Juana assume roles of intellectual leadership, something she had not seen before. As a result, Ms. Pertuz sees students like Serena, whom she thinks of as academically strong, benefit from ideas and perspectives articulated by students whose academic skills are of concern to her.

Second, this science talk reinvigorates Ms. Pertuz's own interest in the science of plant growth. The children's ideas and perspectives stimulate her to think about growth in new ways and to wonder what moment-to-moment growth in a plant might indeed look like. She is left with many exciting potential directions in which to take the children's inquiry. Should they explore growth as three-dimensional? If they were to do this, how might they measure it in their plants? And in themselves? What are other ways of making growth visible and of representing it? (For a more in-depth discussion of this science talk, see Ballenger 2003.)

Of course, Ms. Pertuz did not see all of this during the science talk. That is not possible. As part of adopting a new role for herself, she took notes as the children spoke. She also had the session videotaped. Her notes and the video record enabled Ms. Pertuz to sit down with colleagues at a later time and reflect on what the children had said and done, deepening her sense of their thinking and the possibilities for pursuing their ideas and questions.

Conclusion

In *Talking Their Way Into Science,* Karen Gallas (1995, p. 13) writes, "Children come to school fully prepared to engage in scientific activity, and the school, not recognizing the real nature of scientific thinking and discovery, directs its efforts toward training those natural abilities out of the children." As our case study demonstrates, this does not have to be the case. All children, regardless of their first language or educational background, come to school with rich experiences of the world and ways of accounting for them that can be used as resources in teaching and in learning science. A major challenge facing teachers who teach children from backgrounds different than their own is to learn how to recognize the instructional potential of such resources. Some suggestions follow:

GETTING STARTED WITH SCIENCE TALKS

Here are some simple strategies for getting started with science talks and for understanding your role as teacher in this activity. Science talks may seem unfamiliar at first, but each time you facilitate a science talk, you will find yourself becoming more skilled and more comfortable in leading them.

1. **Engage your students in a common activity with a scientific phenomenon** (such as rolling cars down ramps to investigate constant acceleration or raising plants to examine growth). Give them extended time to observe what is happening, so that all students will have an observation to share.

2. **Initiate an open-ended discussion about the event with your students.** What did they see? What do they think happened? The goal is to provide each student with the opportunity to share thoughts and build common intellectual ground with classmates. Do not be concerned if several students have the same observation.

3. **Listen carefully to what your students say as they share their thoughts.** Look for connections between your students' ideas and the scientific ideas they are studying. Write down, audiotape, or videotape what they say. Doing so will help you focus and will create a record for future reflection.

4. **Encourage your students to talk with one another, allowing them to use a range of language styles to communicate their ideas.** Authentic science talks

often have the spontaneous, informal flavor of out-of-school conversation. Sometimes, this may mean letting students express their ideas in a language other than English. Accept with respect all contributions that are put forward in earnest.

5. **Act as a facilitator, rather than as a teacher, of the conversation.** Use those practices that will allow you to establish a reflective stance toward your students' ideas. The following strategies may help:

Repeat what a student has said, and then invite other students to share their ideas. In repeating, it is important to use the student's words rather than your own.

"Re-voice" what you think a student has said in your own words. Doing so allows you to articulate connections among students' ideas or between a student's perspective and that of science. Invite other children to comment. After re-voicing, follow up with the original speaker and ask if your words represent what she or he meant—allow your student to accept or reject your interpretation and to re-articulate her or his ideas.

Ask a student to elaborate or say more about her or his ideas. This can be especially helpful if you are not sure what the student is saying.

6. **Allow the conversation to develop and unfold with as little intervention on your part as possible.** Let your students introduce you to unexpected perspectives, such as the idea that growth is three- rather than two-dimensional. Think broadly about the scientific phenomenon, and be willing to see it in a new light. You may find yourself interested in learning more about how current scientific understanding developed or aware of places in which the curriculum does not go deep enough to respond to your students' questions and ideas.

7. **Assume that the students understand one another, even if you do not yet understand what is being said.** When a student says something you do not understand, follow up and ask the student to elaborate, explain further, or say more about her or his idea. Alternatively, ask if other students can help you understand. Think of the class as building meaning together.

8. **Reflect on your students' ideas after the science talk has concluded.** Revisit your notes (or audio or videotape) and think about what your students said. Look for ideas or events that surprise, puzzle, or confuse you. Follow up on these with students as seems appropriate.

9. **Consider meeting with other teachers to discuss the science talk and your reflections.** Discuss your students' thinking, the relationship of their ideas to science, and how you can use their ideas and perspectives to shape your own teaching.

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