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Paula A. Magee

Ryan Flessner
Butler University, rflessne@butler.edu

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Paula A. Magee
Indiana University–Indianapolis

Ryan Flessner
Butler University

Setting

For the past 20 years, there has been a push to improve the teaching and learning of science in elementary schools. One strong reason for this was the release of the National Science Education Standards (NRC 1996). The Standards articulated not only *what* K–12 students should know (science content standards), but also *how* science teachers needed to teach (teaching standards) and be continuously *supported* (professional development standards). The Standards also considered ways to support inquiry-based and meaningful science learning for K–12 students (program and system standards). According to the NRC, one of the four reasons underpinning all of this is because "the goals for science education within the school day are to educate students who could increase their economic productivity through the use of knowledge, understanding and skills of the scientifically literate person in their careers" (1996, p. 13). Additional reasons for this push include greater attention to the STEM fields, evolving and expanding global networks, and an ever-increasing list of accountability mechanisms thrust upon schools and teachers (Marx and Harris 2006). Clearly, in order to pursue a career in a scientific field, children need knowledge and skills very different from those traditionally taught in elementary schools. Unfortunately, what occurs in elementary schools is the opposite of what the Standards advocate.

For instance, in many schools across the country, science fairs are held to showcase work completed by students. While science fairs differ in form and function, they generally highlight procedures students have followed to construct hypotheses and collect data to validate or refute the hypotheses. In most cases, science fairs are competitive events with prizes awarded to the most outstanding presentations. Interestingly, these experiences are quite unlike the daily lives of practicing scientists and do not provide students with the opportunities to develop the skills necessary for scientific literacy. In contrast to the children engaged in school science fairs, practicing scientists talk informally on a daily basis; they share their work at professional conferences, and they engage in noncompetitive conversations. Scientists present ideas that are in progress, give and receive feedback, and exchange information in order to move their work forward.

In order for teachers to prepare students to be scientifically literate, we need to rethink the ways we teach science in our schools. This chapter examines the ways we, as educators, engage students in scientific inquiry and the opportunities we provide to children for sharing their work with others. In doing so, we highlight ways that children can experience scientific knowledge, understandings, and skills that align more realistically with the work conducted by practicing scientists. In this way students are able to develop the skills necessary to be more productive in their careers while also inspiring more to try such careers.

We begin with an assessment of the current state of science teaching and learning in elementary schools. This is followed by an examination of our collaborative work with elementary teachers. We describe our approach to professional development in inquiry-based teaching and learning as well as the use of a Kids Inquiry Conference (Saul et al. 2005) as ways for students to engage in conversations similar to those of practicing scientists. We end with an examination of what we've learned about science teaching and learning by creating spaces for professional dialogue between university-based teacher educators and elementary school–based practitioners.

The State of Science in Elementary Schools

Walk into any elementary school and you will see abundant evidence of mathematics and reading instruction. Bulletin boards will usually hold essays, math problems, or other artifacts that represent a strong attention to mathematics and language instruction. Unfortunately, the same cannot be said for science. There are many reasons why science is less a focus in schools. We will describe some of these reasons as well as some of the frustrations teachers face as they attempt to implement quality science instruction in their classrooms. It is important to note that our descriptions of science teaching and learning may paint a picture of teachers as deficient when it comes to science instruction. We suggest, however, that it is not teachers who are deficient. In fact, in our experience we have found teachers to be incredibly capable of engaging in thoughtful scientific teaching and learning. Rather, due to lack of resources, the pressure from accountability mechanisms, or the absence of professional development opportunities, teachers find themselves struggling to implement quality science instruction. It is important to note that the lack of quality science instruction directly impacts the opportunities for elementary students to build the necessary foundational skills for achieving scientific literacy.

The following scenarios were developed using both the stories that teachers and preservice teachers told us as we engaged in professional development experiences with them and our own observations working as teachers, teacher educators, and researchers in elementary schools. While the scenarios are not all instructional, they do all speak to issues (pedagogical, logistical, and knowledge-based) that impact effective science instruction.

Scenario 1: Once-a-Week Science With the Expert

In this model, elementary classroom students may have science instruction once a week. The science is taught as a stand-alone "special area" where the special-area teacher typically focuses on "hands on" activities that are "cookbook" in nature. During most of these activities students are not asked to wonder, explore, "mess about" (Hawkins 1965), or work toward personal sense-making of the science. Rather, they are supplied with step-by-step procedures for activities with prescribed and predetermined results. During these experiences, students may be asked to memorize "the scientific method" and be erroneously asked to believe that scientists follow a lockstep process for problem solving. Most often, this type of instruction is not integrated into the overall curriculum and requires students to do little, if any, critical thinking or problem solving. The lack of real and personal inquiry makes this scenario incompatible with the reforms outlined by the National Research Council (NRC 1996, 2007).

Scenario 2: Meet Your Partner—Social Studies

Another common formula for determining when science instruction occurs is the sharing model that pairs science with another under-represented subject area (often social studies). In this scenario, science may be taught once or twice a week for a grading period (e.g., "first nine weeks") and then it is not taught at all the following grading period when the partner subject is taught. Not only does this scenario imply that neither science nor social studies is as important as reading and math; it also makes integration across the curriculum extremely difficult—if not impossible. When science is omitted from the curriculum, valuable opportunities for students to build scientific literacy skills are lost.

Scenario 3: Let's Read the Text

Reading, comprehending, and "mentally messing around" with nonfiction texts and resource materials are integral parts of strong science instruction. In fact, all subject areas rely on strong reading comprehension skills for personal "sense-making" and critical thinking. These are skills that are invaluable to students as they progress through middle school, high school, and college. They become vital as students graduate from college and enter the workforce.

In science, when resource materials are accessed as a way to help students make sense of relevant questions in which they are interested, the results can encourage dramatic learning and engagement and attract more interest in science careers. However, when science *is* taught in most elementary classrooms, the instruction—and use of critical reading material—is often teacher-driven and pedagogically ineffective. In many classrooms, science instruction starts with a vocabulary list of "key terms" which can be found in traditional textbooks often mandated by school district administrators. Students are expected, usually outside of any relevant context or personal curiosity, to memorize these terms. Following the memorization, students may be asked to engage in traditional activities that often have predetermined results. Usually, input from the students is an afterthought—if gathered at all; and, little, if any, time is spent generating questions or wondering about the science being taught.

Scenario 4: These Kids Can't Do Science

When schools and teachers adopt traditional behavior management systems, practitioners are often reluctant to offer student-driven activities. More often, teachers will work to maintain order in the classroom by controlling as much of the instruction as possible. Especially when schools are under pressure to raise test scores, environments are not typically conducive to rich learning experiences. To compound the situation, research shows that in classes where there are socioeconomic and linguistic disconnects between the teacher and the student population, strict behavior management systems tend to be more prevalent (Smith-Maddox and Solórzano 2002). Since the majority of elementary school teachers are White individuals from middle-class backgrounds (Zumwalt and Craig 2005), this translates to less efficacious science instruction for children of color and those living in poverty.

Why Might This Be the Case?

It is important to stress that the scenarios described above are not surprising given the traditional experiences of many elementary school teachers, fears related to teaching science (e.g., adequate content knowledge, sufficient resources, and sustained professional development). The failures are also noted with increased attention to accountability. In our experiences, preservice and inservice elementary teachers rarely identify science as their favorite subject to teach. Often for these teachers, their own science experiences have been unsatisfactory. These unsatisfactory experiences translate to teacher struggles in two main areas: science pedagogy and science content.

From a pedagogical perspective, science teaching reform initiatives over the past two decades have largely focused on an inquiry-based approach (Bybee 2010; NRC 1996, 2007). This pedagogical approach requires teachers to address several components that often make them uncomfortable. These include: a student-driven curriculum, open-ended questions, and overall flexibility in planning for and implementing instruction. Since this approach is not in line with the more traditional teacher-directed approach—where the teacher knows and chooses the activities, important vocabulary, and the curriculum structure before the students enter the classroom—teachers are often hesitant to embrace inquiry in any form. Teachers' discomfort with an inquiry-based approach can be connected to their own inexperience with both inquiry (Haefner and Zembal-Saul 2004) and issues connected to allowing students to make instructional decisions (Windschitl 2002).

In addition to the lack of experience with inquiry-based teaching, elementary grade teachers often feel underprepared with respect to their content knowledge of science (Buczynski and Hansen 2010). Like the issues around inquiry-based teaching, the dilemmas with content are complex. Simply requiring preservice teachers to "take more science" rarely results in the development of deep, complex scientific understanding; yet, this is often the mandate. Research in science education strongly supports an interactive curriculum that allows students time to develop and test ideas as they work toward personal meaning-making (NRC 2007). However, it has been well documented that high school and college science courses are typically taught from a teacher-directed perspective, which does not allow for the development of rich scientific understandings of science. Many preservice teacher preparation programs require several science courses, but these are usually at the 100 or 200 level and rarely provide the preservice teachers with time or resources to help them think critically about the science content.

Since the majority of elementary grade teachers have not been afforded the opportunity to develop a passion to learn science outside of school, the in-school experiences become even more critical. When these in-school experiences are unproductive, the future teachers are left underprepared. The disconnect becomes even more pronounced when we look at society's incorrect but simplistic view of elementary school teachers and the real meaning of doing science.

Clearly, the complicated process of teaching science using an inquiry approach requires teachers to understand complex science ideas and the ways in which students develop these ideas (Shulman 1986). Perhaps it means encouraging teachers to learn *with* their students. When teachers do not have access to quality science content—and the necessary pedagogy to guide children in scientific inquiry—the impact of science instruction decreases significantly. This affects students' ability to use science and scientific reasoning in their postschool life or to seek science and engineering careers.

Our Approach

Working with elementary teachers through a district-mandated professional development experience prompted us to develop a more collaborative approach where classroom teachers would be supported to develop experiences that supported students to engage in inquiry science. As we have described elsewhere (Magee and Flessner 2011) we see five main strategies that teachers can employ to facilitate authentic inquiry experiences in their classroom. These are:

1. Use "Thinking Starters."
2. Listen to Children's Ideas.
3. Use Standards as a Guide.
4. Develop Complex Questions.
5. Document and Reflect.

Use "Thinking Starters"

For teachers, it is often difficult to know where to start. We have had success with asking students to generate questions after they have engaged with interesting hands-on activities that have been purposefully selected. Knowing that inquiry is a long-term venture, students are most successful when teachers offer intriguing, contextually relevant tasks that lend themselves to real world connections and personal curiosity. One teacher with whom we worked used a homemade compost bin as a "thinking starter." The fourth grade students in her classroom were asked to observe and question. The compost bin (made in a small 9 in. × 6 in. × 2 in. plastic box) was left in the classroom, and students were encouraged to look at it during science time or any other time when they had a moment. This thinking starter generated many good questions and was a constant source of curiosity for the children. Additionally, many of the students had gardens at home and could make connections to that as well.

Another thinking starter a teacher used was paper airplanes. The teacher had a kit that she modified and used in an open and exploratory fashion. Instead of giving children a cookbook list of directions, her students were asked to design paper airplanes, make observations, and develop questions. From the observations and questions that the children supplied, the teacher was able to support the children's inquiry. Good thinking starters can be almost anything as long as the teacher maintains a focus on student ideas and questions and sees the thinking starter as a springboard for further exploration.

Listen to Children's Ideas

While it is tempting for teachers to plan ahead and make instructional decisions outside the presence of children, we have found that the most productive inquiries are built from children's own ideas. While these ideas may not always be—or perhaps only rarely the case—conceptually correct, they do represent the children's sense-making. Looking at these ideas as logical stepping stones in the learning process allows teachers to build from them instead of working to change them into something else (Driver and Easley 1978). For example, a first-grade teacher that we worked with led a discussion with her class about living and nonliving items. The children were discussing the question, "Is a rock living?" The children were divided into three different camps. The first group said that the rock was not living—it could not breathe or eat. The second group said that the rock was living since it could grow (there were clearly smaller rocks nearby). The third group was undecided and felt that there were good arguments from both the other groups. The teacher, instead of affirming that the first group was correct, honored all responses and asked the class how they might explore these ideas further. As a whole, the class devised an experiment to measure the rock, bury it, wait a specific amount of time and then remeasure it to see if it had grown. In addition to content, the teacher was teaching her students how to use evidence to check possible explanations. The teacher recognized that even though this method would take longer, the changes that her students would learn the content with efficacy in fact exemplified real learning. If she had not *listened* to the children, she would not have known what to do next.

Use Standards as a Guide

The teacher in the above story did use the Standards—as many teachers are required to do. While it is sometimes possible, teachers usually do not have the luxury to follow student suggestions for inquiry without some connection to state or national standards. However, connecting to the Standards does not mean that teachers need to abandon inquiry-based teaching or that students do not get the opportunity to learn in the same manner as scientists. In actuality, most scientists are hired to solve particular problems. Importantly, the ideas and decisions for how to *proceed* are often left up to the scientist, but the original problem or dilemma may be one that someone else has requested. We have found that teachers can use the Content Standards as a guide. When they intentionally choose strong thinking starters and listen to children's ideas, the Standards can be a strong framework instead of a constraint.

Develop Complex Questions

One of the things required for good science teaching is a thoughtfully complicated question. Rarely is a "good" question single-faceted. Rather, a series of related questions often emerge. These questions encourage children to dig deeper, make connections, and feel that the inquiry is relevant beyond the project at hand. Additionally, complex questions are rarely answered by finding answers online or in a textbook. In this way, they are much like the real questions that scientists pursue. Because the questions are complex, answering them requires critically thinking about information that is gathered and synthesized. Information is then seen as a way that is contextually relevant! We have found that these kinds of questions promote sustained inquiry where students are engaged for a longer period of time. In the compost bin experience, the students were able to formulate questions such as, "The soil looks darker, why?" It promoted all sorts of follow-up activities and readings.

Document and Reflect

Finally we have found that good science teaching requires documentation, documentation, and more documentation! When children engage in the documentation of their scientific inquiries, they reflect on what they have learned. Science journals provide students with an outlet to capture their thinking through writing or drawing; photography allows children to capture important details that allow for further careful observation at a later date. Responding to teacher prompts encourages children to focus their thinking and to communicate effectively with a specific audience. Each of these forms of documentation allows students to create trails of their thinking and learning that can be revisited throughout the inquiry process.

Sharing the Work—Have a Kids Inquiry Conference!

The teaching described above causes changes to the types of conversations that happen in elementary classrooms. In these classrooms, science becomes less about following a recipe and more about the real work of scientists. Because of this, educators need to engage in alternative ways—other than traditional science fairs—of showcasing the depth of their students' understanding. We have found that a Kids Inquiry Conference (KIC), as described by Saul at al. (2005), accomplishes this feat. Like conferences attended by those working in scientific fields, a KIC encourages children to develop inquiry questions, design projects to explore the answers to those questions, carry out inquiry-based projects, and share their knowledge publically. As university-based teacher educators, we have worked with many teachers in order to prepare for and present Kids Inquiry Conferences. The section that follows explores what we have learned about working collaboratively with teachers and students as we all worked to replace the image of a traditional science fair with that of a KIC.

Working Toward the Kids Inquiry Conference

First and foremost, we believe in trusting relationships that are built over time. In our roles as teacher educators, we have developed longstanding relationships with particular schools, individual teachers, and groups of students. These relationships have been solidified because everyone involved has been willing to commit time and energy to the relationship. This commitment to collaborate is essential to the success of a Kids Inquiry Conference.

As we began to envision the KIC, we worked with teachers to develop a yearlong professional development program that is related to inquiry-based teaching. We were fortunate in that several of the teachers with whom we worked had existing relationships with us from prior professional development work that we encouraged with the schools. This helped us delve deeply into identifying teacher strengths and their needs as we moved toward implementation of the KIC.

Knowing that the Kids Inquiry Conference was the culminating event helped all of us (teachers as well as teacher educators) sign on for a long-term professional development project. With a lofty goal in mind, we all understood the magnitude of the commitment. This also energized us as we set forth with the planning process.

The professional development program that we designed allowed all members of the collaboration to learn from one another. While university-based faculty members are often seen as the experts in relationships like the ones we are describing, we were quick to point out that we were learning just as much from the teachers and the students as they were learning from us. While we have had time to engage in in-depth study of inquiry-based teaching, we are not full-time teachers responsible for a classroom full of children and a host of curricular areas to address. Though we both have teaching experiences, we needed the teachers to remind us of the realities of the classroom, what was manageable, and how to progress in our work together.

To begin our work together, teachers expressed their interests and their needs. The teachers had different understandings of inquiry-based teaching as well as different comfort levels with this type of teaching and learning. Teachers had different expertise with science content, and they differed greatly in the amount of science they actually taught in their classrooms. These differences provided us with a great variety of challenges but also allowed us to structure conversations so teachers who were more comfortable and confident with inquiry-based teaching to share their expertise with those who were less familiar with these ideas. This allowed us to learn about implementation and feasibility from teacher experts, and it allowed other teachers to see their peers in leadership roles.

Teachers met with one of us every two to three weeks. The frequency of these meetings allowed teachers to try new ideas and gradually become more comfortable with the ideas and philosophies behind inquiry-based teaching. We offered support through e-mail and phone conversations; we co-taught lessons with teachers who expressed a need or interest; and we provided resources (books, materials) that teachers requested throughout the process. Because all of us had committed to participating in the Kids Inquiry Conference, we were all able to listen to children and co-construct thoughtful learning experiences that would facilitate the types of conversations, learning, and interactions that are necessary for encouraging careers in scientific fields.

Inquiry-Based Teaching Comes Alive

Because of the teachers' willingness to step outside of their comfort zones, amazing things began to occur. In this section we highlight several of the ways that inquiry-based teaching was manifested in the classrooms of the teachers with whom we worked. We hope that these vignettes allow the reader to understand the many different forms that inquiry-based learning can take and how the experiences support elementary students to envision a career as a scientist.

In one classroom where we worked, one teacher, Leslie*, allowed her children to explore any question that interested them. Students were asked to create a list of questions that were intriguing to them. After the class generated their list of questions, some students decided to work together in groups where there were common interests. Others chose to engage in individual research projects. One student seized the opportunity to explore questions that had arisen in her personal life. This child had been experiencing difficulty relating to a grandparent with Alzheimer's disease. Because the student was personally invested in the study of this disease, she saw purpose in her work, researched diligently, and went far beyond any assignment she would have been required to complete in a traditional classroom. Because of her inquiry, the child was able to ask specific questions based on her experiences interacting with her grandparent. Her diligence in her research allowed her to further interact with her relatives, ask new questions, and dig deeper to understand the struggles that those with Alzheimer's face. This example is a remarkable instance of a teacher facilitating academic growth by allowing students to make connections to their lives inside and outside of school. Often students actually learned more from other students—encouraging further input from them as well as in their own lives. The teacher and the student were also engaged in discussions about the scientists who work in laboratories and hospitals to learn more about diseases like Alzheimer's. According to the teacher "Jesse was so excited to consider that she might be able one day to work in a lab that cured diseases like Alzheimer's. The KIC project supported her seeing herself as a scientist."

Another teacher, Kathy, was able to use inquiry-based teaching to address State Standards in the area of science. Rather than beginning with the Standards and creating lessons that were disconnected from her students' lives and experiences, the teacher began by listening to her students. She realized that her students had an interest in worms. By engaging them in thoughtful dialogue, listening to their ideas, and *then* connecting these ideas to State Standards, the teacher was able to create a robust unit on "interconnectedness." In doing so, she was able to facilitate student learning as they answered questions such as, "How does the anatomy of a worm affect soil?" and "How are other animals living in the soil impacted by worms?" Student ideas were honored, standards were addressed, and inquiry-based teaching was validated as a way to build connections between the real world and academic content.

In one final example, Mary, a teacher in a kindergarten/first-grade multiage classroom, listened to her children's ideas surrounding the concept of recycling. As she listened, she began to wonder if students were confusing the concept of "reusing" with the concept of "recycling." Because of the discussions they were having, the teacher decided to introduce the concept of "reusing" in a class meeting. As the children engaged in conversation with the teacher, they identified times when objects should be recycled and when they could be reused. For example, the students quickly realized that objects such as cardboard boxes could be reused to create dollhouses for the play area or game boards for the math games which they were creating. In this classroom, deliberate conversations led young children to become aware of how waste was

* Teachers' and students' names have been changed throughout this chapter in order to ensure confidentiality.

managed in their classroom on a daily basis. These conversations linked to larger conversations in the school community about sustainability and showed that young children can understand complex topics that have an immediate impact on their lives and the world.

Alerting Teachers and Students to Conference Basics

From the beginning of our collaborations, we—along with the teachers—were clear with the students about the Kids Inquiry Conference and their role in the KIC. Initial conversations always lead children to ask about where the conference would be held and whether or not they would have to present in front of a "big group of people." Students become excited when they realize that they will be presenting on a university campus or that a group of students from another school will come to their building to engage in the Kids Inquiry Conference. They also relax their shoulders and begin to breathe more slowly when they realize they will not have to present in front of a huge group of adults! However, they also understand the importance of clearly documenting their learning in an effort to communicate effectively with their audience. In the classrooms where we worked, students and teachers together documented the process of inquiry-based learning. This was done through the use of science journals, research logs, photography, and posters that documented the learning that occurred in the room. Documentation helped students communicate their understanding to others; it also deepened their own understanding of their investigations. Rather than creating a typical science fair project (where a topic is chosen, a hypothesis is made, and students spend their time collecting data to support or refute the hypothesis), the Kids Inquiry Conference format allowed students to document their understanding of their work in progress and further their own questions. In this way, children developed presentations for the KIC that focused on continually challenging working explanations, engaging in dialogue with others, and asking new questions. We and the teachers also reminded the students that "real scientists" work in very similar ways. Since one of us (Paula Magee) had been a practicing research chemist, we were able to answer questions about what it was like to be a scientist working in the lab. The elementary students were extremely interested in those perspectives. We interpreted this as the development of a growing interest in science careers.

Preparing for the KIC

A few weeks prior to the Kids Inquiry Conference, teachers began to engage children in a discussion about how they would share their work. Most of the groups decided that they would use display boards to showcase their learning. One teacher asked children to work with her to create a list of items that should be on each child's or group's board. These items included:

1. a title for the project
2. "Big Questions" linked to photographs, illustrations, or other representations designed by the students
3. a clear timeline of the daily work from the start of the project
4. research and findings from books, the internet, and other sources

5. discoveries and observations from students' own personal activities
6. further questions that arose throughout the inquiry process
7. a final question to guide further inquiry

As students practiced their presentations for the big day, they were able to use these posters as visual aids and as a way to organize what they wanted to say to their audiences. Because few students had experience systematically documenting their learning or presenting that learning to others, the boards became a tool to organize their thinking in a way that facilitated communication with an audience.

Presenting the KIC

Kids Inquiry Conferences are where children have opportunities to engage with an audience but also with each other. Because of this, we deliberately structured times where teachers, university faculty, students, parents, and other visitors could interact. Regardless of the setting of the conference, the conferences we have helped to organize have always been kicked off with a gathering of everyone involved. These "opening ceremonies" allowed everyone to see the large numbers of people involved and interested in the work. In addition, this initial meeting allowed those leading the conference to explain how a Kids Inquiry Conference differs from a traditional science fair. At this meeting, the schedule of the day was reviewed. It is important to note that prior to this meeting, we recruited volunteers (teachers, preservice teachers from our university courses, parents) who understood the flow of the day, directed traffic, and answered questions throughout the conference. These volunteers are essential to a successful conference. And their value cannot be overstated.

After the opening meeting, students headed to different rooms (assigned prior to the start of the day). In each room, groups of students from different schools gathered to present their work. We purposely integrated children from similar grade levels but from different schools to encourage dialogue between and across schools. In these rooms, tables and chairs were available for children to use in setting up their displays.

Three 15-minute rotations were scheduled for students to present their work. Groups took turns presenting their projects to the other students in their room. Other visitors circulated amongst the rooms as children presented. During these presentations, children knew that their objective was to share, and listen to, understanding that was gained throughout the inquiry process. Students developed an appreciation for the work that scientists do and recognized that being a scientist required excellent communication skills. This was evidenced by students saying things such as "scientists do so many things" and "I like being a scientist!"

After the third rotation, a large-group discussion ensued. Chairs were gathered in the middle of the room and a circle was formed. An adult facilitator in each room engaged children in a discussion of what they had learned. Children noted ideas that intrigued them, questions that were left unanswered, and ways that others had helped them think about extensions for their work. Preservice teachers from the university were asked to prepare questions prior to this discussion if, in rare instances, children had nothing they wanted to discuss. In addition, these college students acted as time keepers to ensure that the discussion did not exceed the scheduled minutes.

After the discussion circles, students rotated through the other rooms of the Kids Inquiry Conference. Children took turns rotating to see the projects of their friends, their siblings, and students from other schools. Again, specific times were scheduled for group presentations, and other times were scheduled for each group to rotate through other rooms. With this schedule in place, students had the opportunity to engage with children outside of their assigned room, but movement among several rooms was organized and manageable.

What We Learned

Experience and Continuity Matter

Make a Kids Inquiry Conference an annual event and a way of teaching science. As we write this chapter, we have completed two Kids Inquiry Conferences. There is no doubt that participating in KICs has been extremely helpful for the teachers. We saw teachers willing to try different things and allowing kids to behave in ways that were much more congruent with the real work that scientists do.

For example, Stacey, an experienced fourth-grade teacher, participated in both conferences. During the first KIC, she was very attentive to "staying with the standards" and needing to control the choices that the students made. During our pre-KIC meetings she often expressed worry that the students might not be learning or that they would be out of control, behaviorally. After the first conference we met and she shared her thoughts on the children's learning, saying, "I cannot believe how much they learned. They didn't just memorize answers, but they actually *knew* the information about composting [the topic under investigation]. I know that they will retain this information and understand it with great depth." She also expressed great relief that, for the most part, the students remained on task and engaged. This original experience set the groundwork for Stacey to push herself and the students further during the second year of the project.

During the months leading up to the second conference, Stacey was much more willing to let her students make decisions about the project, this time concerning the concepts of force and motion. The students designed race cars and Stacey said, "I want them [the students] to make all the choices in the design. I know that the more they can make these choices the more they will learn." This narrative reminds us of two important things. First, the original experience gave the teachers an authentic opportunity to "mess around" with inquiry-based teaching and a student-directed curriculum. Teachers, like students, learn through the process of *doing and sense-making*. The original KIC and the professional conversations that led up to it supported the teachers to think about and challenge notions of teaching that they had. Second, knowing that a second KIC was going to definitely occur opened the space for teachers to go a little further with respect to student decision-making. During the second year the teachers were able to concentrate more on the inquiry itself since they already knew what to expect of the conference. Making a commitment to an annual event instead of a one-time shot increases the potential for meaningful experiences tremendously. At the time of this writing, we are preparing for our third KIC, and we are hoping to increase the number of participating teachers at the school from 6 to 12.

Inquiry-Based Teaching Encourages Student Independence

> My students thrived with the hands-on and minds-on work of the flight investigations. They loved experimenting and making the paper airplanes. I could tell how much they learned about how and why planes fly. One student even told me that he wants to be an "airplane scientist."
>
> —*Kelly, fourth-grade teacher*

In addition to being productive for teachers, the KIC and inquiry-based teaching are extremely beneficial for the students. The experience of preparing for and participating in a KIC encourages students to behave and think like practicing scientists. While they are working on their projects, students are generating questions, preparing "working explanations," and devising ways to make sense of their ideas. This sense-making includes setting up experimental activities, reading the work of experts, and thinking hard about what it all means. Students, like scientists, create opportunities for using evidence-based thinking in a real-world context.

Unlike a process-skills approach, where students might learn academic skills in isolation, the KIC supports students' work from the outside in—look at a problem, question, or curiosity and use scientific thinking to better understand it. This is the way that practicing scientists approach their work, and an inquiry-based approach supports elementary students to do the same. When students have opportunities to see themselves as capable learners and understand that science is not about memorizing answers but making sense of things using evidence and ingenuity, then we can expect students to develop the kind of scientific thinking skills that are in alignment with the National Research Council's (1996, 2007) Standards and the work of practicing scientists. This experience helps students develop self-efficacy that can lead to pursuing science careers. The KIC resulted in many student ideas about being a scientist; one of the major outcomes was more elementary school students liking the idea of being a practicing scientist!

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