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Growing Seeds and Scientists

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Kindergarteners become a community of scientists as they explore seeds and plant growth

How do young children develop their ideas about science and scientists' work in their first year of school? How do we teach them to believe they are real scientists? In this article, we—a university science educator, a kindergarten teacher, and a Penn State University teaching intern—share our inquiry into these questions in a kindergarten classroom during an exciting, six-week unit on seeds.

Research and Planning

The three of us spent four after-school sessions (about 1.5 hours each) pulling together resources and planning the outline for the unit. As the unit unfolded, we debriefed each day, and once a week met after school to plan the next week's lessons.

We started with the district's plants unit, which focused on seeds and their conditions for growth, and plants, their parts, and their conditions for growth. We then searched the *National Science Education Standards* (NRC 1996), the *Benchmarks for Science Literacy* (AAAS 1993), and *Inquiry and the National Science Education Standards* (NRC 2000), for related concepts about seeds and plants and scientific inquiry in grades K–2.

We next considered which of those concepts students had already learned in a "plants and their needs" unit earlier in the year. Children had learned that plants need water and sunlight to grow, so we chose to focus this unit on seeds, their structures and functions, and growth into plants. In this unit, we wanted to help students understand where plants come from and how they grow.

Then, we examined the research on children's thinking about plants and growth. We found that children sometimes think that grass and trees are not plants (Barman et al. 2003) and that plants take in food from outside themselves (Roth 1985), just like people. We also knew that young children, just as many adults, have stereotypical views of scientists and their work (e.g., Barman et al. 1997; Schibeci and Sorenson 1983).

Next, we read and discussed the National Research Council's report, *Ready, Set, Science!* (Michaels, Shouse, and Schweingruber 2008), with its new vision for K–8 science. Michaels and her colleagues provide a summary (and classroom vignettes) for educators based on the research report, *Taking Science to School* (Duschl, Schweingruber, and Shouse 2007). The authors argue that young children are more capable of engaging in scientific reasoning, discourses, and practices than previously thought. They describe four important strands of scientific proficiency to weave within and across science lesson.

Strands:

1. Know, use, and interpret scientific explanations of the natural world (e.g., seeds have stored food in their cotyledons and use that to start growing);
2. Generate and evaluate scientific evidence and explanations (e.g., some seeds are not growing because they have too much water);
3. Understand the nature and development of scientific knowledge (e.g., placing the same kinds of seeds in each of three baggies with different amounts of water); and
4. Participate productively in scientific practices and discourse (e.g., "I disagree with Jeremy, because I think the water is the food for the plant.")

Synthesizing these sets of information into a coherent unit gave us a lot to talk about. We also realized that we needed to find out what our kindergartners thought about seeds and their growth before we could begin any unit lessons.

We asked the children to share their ideas about seeds, what they needed to grow, what plant parts developed as the seed grew, and what scientists did when they went to work.

Students relied almost exclusively on appearance when deciding whether objects were seeds or not. None of the students thought there was anything inside the seed, except possibly another "baby" seed. Few students had ideas about scientists and their work, except for the usual "blow things up" and "help people" perspectives that often persist into the later grades (e.g., Barman et al. 1997).

We revised our initial planning in two more after-school meetings. We decided the first lessons in the seed unit needed to be about what made something a seed and how to test those ideas. Since children's ideas had focused on the appearance of the seeds, we started with "How do we tell if something is a seed?"

Seeds and Scientists

In April, we started the seeds unit by gathering children in a circle on the rug. We reminded students of their earlier investigations about plants' needs and asked students to teach our visitor, "Dr. Deb," what they had learned. Children described how they had studied four identical chrysanthemum plants, one in the closet with no light, and three on the counter in the Sun. Each of the plants on the counter had received very different amounts of water, and children described how the first plant was dying because it got so little water, and the second plant was healthy because it got enough water. They were very clear that the plant inside the closet was dying because it got no sunlight.

The three of us explained that grown-up scientists often meet together in a "scientists' conference" to share ideas and to learn from each other (strand three), and that we were going to do the same. We wanted students to understand that they were sharing their ideas not just to have a turn, but also to teach others and develop shared understanding (strand three).

Next, we asked the students what they thought would happen during a scientists' conference. How would scientists get a turn to share their ideas (raise your hand)? What would they do when another scientist was talking (look, listen, think, respond, and learn)? What would they do if they had a different idea (take a turn to share)? We modeled scientists taking turns, sharing ideas, having different ideas, and giving reasons for ideas (strands three and four).

We continued our first scientists' conference by asking the question, "How do we know if something is a seed?" Students looked at the objects of different sizes, shapes, and colors (a lima bean, avocado seed, small stone, tiny sea shell, marigold seed, corn kernel, green bean seed, daisy seed, pea, and carrot seed) that were on a plate in the middle of the rug. Teachers reminded students that they were observing the items, not tasting or eating them. CAUTION

Students offered their thoughts as to why an object might be a seed or not (strands two, three, and four). As children shared their thinking, they focused on size (the avocado was "too big"), color ("seeds are black"), shape ("too pointy"), or texture ("too bumpy"). Children disagreed about almost every observable attribute that they thought was important for identifying a seed.

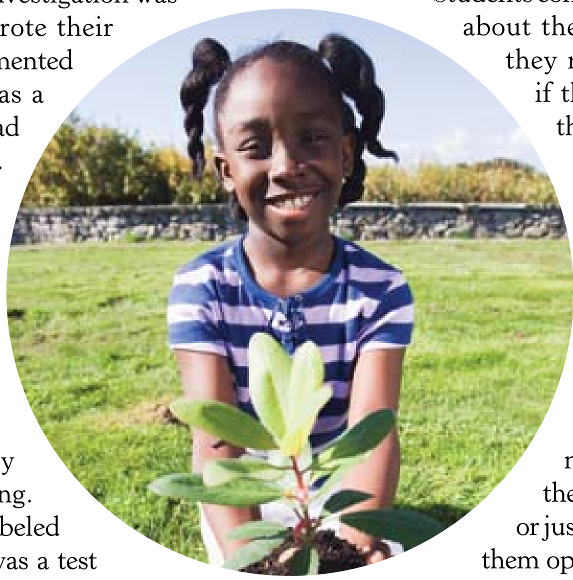
Students' disagreements raised an important teaching point about scientists' work—that scientists can disagree. During the discussion, we pointed out that grown-up scientists share their ideas, just as they were doing, and sometimes even disagreed with each other (strand three). Then, the teachers modeled ways of talking like grown-up scientists, such as by using the terms *agree* and *disagree* as a way to respectfully respond to another child's idea or by responding to ideas with statements like, "I have a question," or "I have a comment." In this way, students saw respectful ways to share their ideas; as the unit progressed, we observed that students began to ask questions of each other, offer comments, and explain why they disagreed (strand four).

Evidence and Explanations

Given that children disagreed about what made something a seed, we explained how scientists tried to figure out ways to "test" the different ideas that they had (strand three). We asked the children, "How could we find out? How could we test our ideas?"

Jeremy and Carol proposed planting the different objects in soil and watering them. The class decided to plant all the objects in potting soil in a single, clear plastic dish so that we could watch them and gather evidence (strand 2). Know the source of your soil, and make sure students wash their hands after handling soil.

When the corn seed first started growing roots, the children were excited that their investigation was working. Students drew and wrote their observations daily. Students commented that the object they thought was a stone was not growing, as they had predicted when we planted them. However, some of the items they were convinced were seeds had not grown either, and children wanted to replant them, to make sure (strand two).



When we introduced new objects that might be seeds, this time—instead of relying on appearance—students immediately proposed testing them by planting. Each child chose five objects (labeled with different letters, since this was a test of whether they were seeds) from a range of 12 items that might be seeds but differed greatly in appearance (marigold, lettuce, sunflower, green bean, corn, beet, pebble, daisy, carrot, radish, tomato, and cucumber). This time, they planted each object in a clear plastic cup. They watched carefully to see what would grow. Each day, they drew what they saw in their cups, wrote their observations and ideas in their science notebooks, and measured how tall the plants were (strands two and four) with centimeter cubes.

As the plants grew, the students noticed that identical seeds (e.g., all identified by the letter B) were growing in one cup, but not in another cup. They wondered why this was happening. Since not everyone had planted the same five objects, it was difficult to compare all the cups and find patterns. We decided to help the children make a chart that showed how many of each type of seed were growing across all the cups. (We had a record of each seed and the letter used to label it.)

Students wrote their names on a square on the chart for each of the five objects they had planted and colored it green if it was growing. Then, we held a scientists' conference to discuss the results. It was clear (and puzzling) to the students that—for every different seed—there were some plants growing and some not, and that this was true for every seed planted. We had answered our first question—whether these were seeds—but now a new question had emerged, "If they were seeds, why were some growing and others not?

Students proposed possible explanations for the patterns on the chart. Amanda thought maybe her seeds "needed a little more time." Mack suggested, "Maybe the teachers watered them different amounts." Jerome thought maybe he had pushed his seeds down too far in the cup. In each case, children used evidence from their cup gardens to pose possible explanations for what they were observing (strands one and two).

Students continued to observe, draw, and write about their cup gardens. In some cases, they replanted the same seeds to see if they would grow or not, pushing them further down in the dirt. For many students, these replantings did sprout and grow, providing more evidence to share during our conferences.

As the seeds grew, children began questioning where the stems, roots, and leaves came from: "How do they get all that stuff inside the seed?" Given that most of the students had said that there was "nothing" inside the seed, or just a "baby seed," we decided to help them open a soaked lima bean seed with a toothpick and look at the parts inside. Students thought the "tiny thing" (embryo) inside the seed was another "baby" seed that would grow. They used magnifying lenses to notice the leaves and root that made up the "tiny thing." They decided the "white stuff" on either side (cotyledons) was protection so the baby seed didn't get hurt. When we asked students how we could test those ideas, the children wanted to plant whole limas, the "tiny things" (embryos), and the "white stuff" (cotyledons). Teachers suggested planting each separately in clear baggies, and watching what grew. When the "baby seed" didn't grow by itself, but the whole bean did, children were surprised. Students noticed that the roots, stem, and leaves grew from the "baby seed" when the "white stuff" was attached, but they still thought the cotyledon was just protection.

We decided to act out what the "white stuff" did for the baby plant. We talked with the students about how they got the food they needed to grow, and students described how their parents gave them food from the store. We asked, "How could a seed grow in the ground with no parent to bring it food?" We reminded students of the "white stuff" they had seen on each side of the baby plant. Then we gave Jeremy a lunchbox for each arm, which we told students was similar to the "white stuff" on each side of the baby seed. We explained that the baby seed came already-packed with food from the parent plant (just as their parents packed them a lunch), and we asked Jeremy to slowly grow up and put out roots (legs), stems (arms), and leaves (fingers). As Jeremy stretched upward from the rug, we described how he was using the food packed on either side to grow and make new parts. Students smiled and talked about how the baby plant had a parent that gave it food to grow, too.

Over 18 lessons, we saw children grow in their use of scientific talk (e.g., "I have a question for Marcus"), their design of investigations to test ideas (e.g., how do we know how much water is best for seeds?), their use of representations (e.g., writing, drawing, graphing, discussions of evidence), and their generation and use of explanations for results.

Assessment and Reflections

At the end of the six-week (three lessons per week) unit, almost every student explained that if something was a seed, you could open it up and find a baby plant and food inside. Even for new objects, children thought—if it were a seed—it would have a baby plant and food inside. Students also described how the baby plant used the "white stuff" for food (strand one).

When asked how to plant a seed, each child warned about giving it too much water based on their own experiences. Equally as important, students confidently claimed that they were real scientists because they asked questions and had scientists' conferences (strand four); tested ideas (strand two); measured, wrote, and drew in their notebooks (strand four); and figured out together how seeds grew (strand three).

We found that our kindergarten children were, indeed, capable of engaging in the four strands from *Ready, Set, Science!* when we designed opportunities for them to do so and scaffolded their thinking and talk. We have learned from our exploration of one domain of the science curriculum and plan to continue our work in other content domains. We hope that our work is helpful to other teachers in providing some glimpses of what is possible with young children. We encourage others to explore the four strands in their classrooms and to share their ideas and findings, too. ■

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Connecting to the Standards

This article relates to the following *National Science Education Standards* (NRC 1996):

Teaching Standards

Standard B:

Encourage and model the skills of scientific inquiry, as well as the curiosity, openness to new ideas and data, and skepticism that characterize science.

Content Standards

Grades K–4

Standard A: Science as Inquiry

- Abilities necessary to do scientific inquiry

Standard C: Life Science

- Characteristics of organisms

National Research Council (NRC). 1996. *National science education standards*. Washington, DC: National Academy Press.