Forget the Facts and Remember the Wonder

Turning Curiosity into Inquiry

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The children hovered closely around the large galvanized tub full of water. "Some friends thought the cotton ball would float and the paper clip would sink. Others friends thought **both** *the cotton ball and the paper clip would sink. Let's see what happens." The children waited silently in anticipation as the teacher dropped the items into the water. "Whoa!" gasped some of the children as the paper clip immediately sank, and the cotton ball soon followed. "The cotton ball sank," observed the teacher, "Why do you think that happened?" "It filled with water!" "It's heavy!" "What about the paper clip? Why do you think it sank to the bottom?" "It's gray!"*

Let's take a moment and reflect on the last comment. What does this child know? What, possibly, do they not know or have yet to consider? Science is the pursuit of meaning, patterns, and truths about our world. Through everyday encounters at home and school, children naturally acquire knowledge about the world they live in. The round ball bounces high. The soil feels wet after the rain. I see stars at night. In the case of the vignette, the child was, perhaps, relating an observed outcome to generalized encounters with heavy items; some heavy things are gray (metal). While the child's explanation was somewhat naïve in its conception (e.g., not all gray things sink), their comment draws attention to the power of observation. ***Young children rely heavily on what they see to make sense of wonders.***

As children grow, their search for meaning takes on new intentionality and focus; they begin to experiment. "Scientific thinking involves both a prediction and a method of testing the prediction; it comes about when a child both predicts and plays with an outcome" (Forman, 2010, p. 1). *If I add red to the blue, it will turn purple. What will happen if I add brown*? Preschool-age children explore materials, ask questions, investigate, record and represent their work, reflect on what they have done and what it means; they create new theories or ideas about how the world works. They demonstrate strong initiative in pursuing information, but they may be limited in their ability to formulate informed hypotheses and pursue controlled studies. They may "test" ideas in a haphazard fashion or misunderstand the variables contributing to an outcome.

At one time, science education focused heavily on memorizing facts and rote learning experiences. There was a flaw, however, in this educational plan. Fact-based education asks children, quite literally, to "check" their imaginations at the front door. As Darrell Hammond cautioned in a recent article from the Huffington Post titled *If We Don't Let Our Children Play, Who Will Be the Next Steve Jobs?*, rote learning fails to "inspire children's curiosity, creativity, and imagination" and denies them "opportunities to tinker, discover, and explore" (2011). ***If children are not permitted to play with science and are educated simply to remember facts, we leave little room for children to enter the "world of invention"*** (Forman, ND). Also, consider the fact that facts change. For example, Pluto is no longer a planet!

Researchers have described young children as innate investigators; they are "scientists-in-waiting" ready to explore, describe, and gather data about their natural world (Gelman, Brenneman, Macdonald & Román, 2010). Adults can help shape a child's ability to wonder and productively find answers to their investigations. As articulated by Conezio and French (2002), "Real science begins with childhood curiosity, which leads to discovery and exploration with teachers' help and encouragement…Young children, like scientists, need to

practice the process skills of predicting, observing, classifying, hypothesizing, experimenting, and communicating" (p.14). Our role then is to plan and prepare for such scientific inquiry; ***forget the facts, and remember the wonder.*** Following are ideas for encouraging and facilitating the process skills for science through meaningful play experiences.

Promote Observation

When we watch children at play, we are able to see the inquiry process unfold before our eyes. Furrowed brows, persistent modifications, and expressions of wonder all indicate a child in the midst of an exploration. An infant watching leaves blow in the wind, a toddler squatting over an ant on the pavement, or a preschooler submerging a wooden spool underwater only to watch it float back up to the surface after being released; all of these young children are actively investigating their world. ***Observation is the first and perhaps the most important step in the scientific inquiry process;*** we must gather information about living things and matter in order to determine their defining characteristics and properties.

Adults can promote children's observation skills by adding language to their work. For infants and young toddlers, you can describe what you see. "*The wind is blowing the leaves. It is blowing your hair, too!" "The ant looks busy carrying that small crumb. Let's watch to see where it is going.*" Ongoing commentary provides children with vocabulary to match their exploration; caregivers should label living things, describe colors and appearances, define textures, and articulate actions. Additionally, the descriptions adults provide serve as a basis for making comparisons between objects of focus. "*The stem feels smooth, but the leaves feel rough. The leaves have fuzzy bumps. I don't see fuzzy bumps on the stem.*" Language from adults prompts children to notice similarities and differences, and inspires them to sort and classify items. This intentional support lays the foundation for more focused investigations.

Model the Use of Science Tools

With increased concentration and expanded attention spans, older toddlers and young preschoolers are ready to explore simple science tools such as magnifying lenses and balance scales. Science tools help children use their senses to focus their investigations. They help children observe, measure, extend their investigations, and track data. Children use tools to make observations and comparisons.

For example, magnifying lenses assist a child's eyes to observe small details. "*The walking sticks do have eyes*!" Balance scales help a child quantify the weight of an object or a collection of objects. While a child could use their muscles to define the heaviness of two items, their senses may be challenged by items that are similar in weight. "*That plastic elephant was heavier than the wooden one*." Other simple science tools include flashlights to illuminate the environment or objects, muffin tins for sorting items into like categories, tweezers for picking up small objects, and pipettes for dispensing small amounts of liquid.

Children should be permitted time to first study science tools. ***Supplying them with open-ended materials that promote exploration (e.g., a bowl of dry beans with tweezers) allows children to discover the purpose and practice the use of a science tool.*** Children also benefit from an adult model. Language, again, plays an important part in adult support. Statements such as "*Let's see how we could use this flashlight*" or "*I'm going use my magnifying glass to take a closer look at the pinecone*" draw attention to the adult's actions and pursuit of information.

Implement a Predict-Check Process

Some parents and early childhood educators avoid science because they think they need to have all the answers to children's questions. Perhaps they also think children are incapable of comprehending scientific phenomena. Both assumptions are incorrect. As stated previously, new attention is now being drawn to the importance of wondering alongside children. In particular, older preschoolers are eager to engage in inquiry, often referring to such experiments as "real science."

When children observe a pattern of outcomes or experience disorder in a perceived pattern, adults can encourage them to form a hypothesis about what they observe to be true and then prompt them to test their idea. Educators refer to this as the "predict-check process." It is important for adults to facilitate rather than direct a child's investigations; ***quality science experiences develop out of a child's own interests, not the agenda of an adult.***

Adults can encourage children to think about their current investigation and pursue scientific inquiry by using the following strategies:

- Facilitate observation and interpretation by asking open-ended questions and accepting a wide range of answers. This shows children that they and their ideas are valued.
  "What's happening? What do you think the earthworm is doing?"
- Encourage children to be specific in their descriptions.
  "Tell me more…"
- Ask children to relate their observations to observable data.
  "How do you know?"
- Add comments.
  "*I noticed when you added a lot of soap the bubbles were bigger and lasted a long time. I wonder if the same thing would happen if you used more water."*
- Help children summarize the sequence of logical thinking that led to a conclusion. Paraphrase to provide children the support they need to articulate their ideas.
  "So you think the rock is heavier than the feather because it is hard to carry."
- Look for developmentally appropriate ways to challenge their working theories.
  "You think gray things sink. I have a gray pen. Will it sink or float?"
- Offer children relevant vocabulary and model ways of thinking about and talking about their experiences.
  "Oh, I see. When you said gray things sink, you meant things that are metal."
  "Let's see what happens when I add another block. I think it might level out the scale. Aha! Four blocks weigh the same as two rocks. The scale is balanced."
- Give accurate information. It is better for adults to say, "I don't know" than to perpetuate or encourage misconceptions.
  "I don't know how spaceships reenter the earth's atmosphere, but I have a book that may help us find out."
- Use children as a resource for each other. Science is inherently social; adults can serve as facilitators of communication, articulating differing theories.
  "You think the wadded piece of paper will hit the ground first, but Nerissa is saying the flat piece of paper will hit the ground first."
  "Tristan noticed something different. When he added pepper to the water, it did not dissolve. Pepper must be different than the sugar you are using, Yiorgos."

Encourage Documentation

As scientists conduct experiments they collect and record data. Children, when encouraged, can do the

same. Documentation makes learning visible. Records of children's work can help make connections between different play experiences and can make play more than a hit-or-miss process. Adults can

use visual displays to compare across days, children, and materials. "*Yesterday you said…*" or "*It looks like Myrna thought…*" Documentation can support children to problem-solve and make connections between materials and strategies ("*What did we use these for the other day*?"). It also provides an opportunity to develop the children's abilities to draw symbolic representations—scribbles, to pictures, to letters, to words.

Children will convey their ideas differently depending on their developmental level and interest. Some children will talk, some will draw, and others will write. To match each child's preferred style of communicating and recording ideas, adults should make a variety of documentation tools available to children: paper, writing instruments, colored pencils/markers, and a digital camera. Loose parts (e.g., cardboard, recyclables, manipulative toys), for creating models, allow children to represent their ideas in three-dimensional form. Children generally require adult guidance in initiating the documentation process. Adults can model data collection and documentation while children work. *"You figured out how to mix the colors to create orange! I'm going to write down your idea in case another friend would like to learn how. What colors did you use?"* Or "*Let's see…your idea was that this car would go faster than the other and it did. What do you notice about the design that made it go faster? Let's draw a picture of what it looks like*."

Planning for scientific learning requires that we attend to children's opening questions of interest. Our purposeful effort to connect with children's interests leads to more attentive investigation and meaningful learning. Adults, both at home and school, with a trained eye and an open mind are able to use a child's natural curiosity about the world around them as an opportunity to promote inquiry. Whether it be digging for worms in soil, testing the flight of a paper airplane, or mixing water and soap to create bubbles, each moment has value in terms of children's science learning, and especially so when they are partnered with an enthusiastic adult.

"If a child is to keep alive his inborn sense of wonder, he needs the companionship of at least one adult who can share it, rediscovering with him the joy, excitement, and mystery of the world we live in" (Rachel Carson).

Additional references available upon request.