CHAPTER 2

What Children Gain by Learning Through Inquiry
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Curiosity is a fundamental human trait. By valuing this natural impulse to learn, the inquiry process can give children the direct feedback and personal experiences they need to shape new and enduring views of the world. This essay points out how inquiry can make a difference in the way children acquire and understand scientific concepts.

Where do butterflies come from?
What causes clouds?
Where does the sun go at night?
Do ants bite?
Why does it get dark quickly in the winter?
How do you make a flashlight light?

From an early age, humans puzzle over phenomena of nature they encounter and ask many questions about them. Whether asked verbally or in actions, these questions indicate curiosity—an intense desire to know or to find out. Curiosity is thus a fundamental human trait. But how does one find answers to these questions? Is it by inquiring into them directly, or is it by obtaining answers from those who already know them?

What we do to get an answer to a question, and how we know when an answer is "correct," are also indications of human curiosity. Since curiosity is at the center of inquiry, these questions too are an integral part of inquiry, which in turn must be a human habit of mind and learning.

The *National Science Education Standards*, developed by the National Research Council (1996), elaborate major components of learning and teaching science through inquiry. "Students at all grade levels and in every domain of science," it states, "should have the opportunity to use scientific

inquiry and develop the ability to think and act in ways associated with inquiry, including asking questions, planning and conducting investigations, using appropriate tools and techniques to gather data, thinking critically and logically about relationships between evidence and explanations, constructing and analyzing alternative explanations, and communicating scientific arguments" (p. 105). Although this definition refers to qualities of inquiry that are especially related to the learning and practice of science, inquiry also relates to learning in other areas of study.

Communicating Through Action

Inquiry is at once a practical and an intellectual activity. In young children, inquiry frequently focuses on tangible items that are of immediate interest. For example, when a toddler slides off a couch and for the first time lands on her feet instead of falling flat on the floor, she may climb back onto the couch and repeat the activity. The child might do this several times, exhibiting delight each time she lands on her feet. It is as though the toddler is wondering: "If I do it again, will I land on my feet? And will it happen that way if I do it yet again, and again, and again?" The child builds upon this knowledge to successfully accomplish other tasks—hopping from one point to another, for example, without falling flat on the ground. This kind of behavior is one of the early indicators of human inquiry and of how humans utilize inquiry experiences to aid their intellectual development.

But although the toddler might successfully hop from one place to another, the experience by itself does not provide her with an explanation of how she accomplished the task. An explanation is the result of combining intellectual activity with discrete facts gathered through inquiry. The development of explanations is an essential component of science inquiry activity.

When they engage in learning activities characterized by inquiry, children provide a window through which we can "see" their thinking and analyze the knowledge and dispositions they bring to bear on their activities. In turn, by having direct contact with children's questions and with children's ways of answering them, teachers gain valuable knowledge regarding developmental stages reached by their students. They can assess the children's questions—what they are and how they are framed. They can observe the children closely to see the tools they use, the data they collect, and what they consider in their attempts to answer their

questions. They can listen to the children's conversations and discussions of the processes, outcomes, and science meanings of their inquiries.

Inquiry is thus a powerful strategy through which children can communicate the state of their knowledge. When students connect batteries and wires to successfully light a bulb, for instance, not only do they communicate the state of their knowledge about the physical aspects of electric circuits, they also provide valuable opportunities for a teacher to help them build upon that knowledge. As the children's cumulative knowledge and experience increase, they are better able to acquire additional science concepts associated with their work on electrical circuits, such as resistance and current flow.

Making Decisions and Acquiring Concepts

Generally, children have limited opportunities to make important decisions—especially those which are taken seriously by adults. Learning through inquiry continually provides children with the opportunity to make firsthand decisions. They can decide which questions to raise at various points, which ones to follow in depth and why, what science tools to use for various tasks, how to organize data, how to portray the patterns created by the data, and what conclusions to accept or reject as they work. It is also of significance that children learn to develop their decision-making capacities in collaboration with their peers, and with a teacher's assistance.

Children's engagement in science inquiry gives them the opportunity to receive accurate feedback directly from the outcomes of their own inquiry.

One important ingredient of intellectual and scholastic development is being aware of one's own state of knowledge. Children's engagement in science inquiry gives them the opportunity to receive accurate feedback directly from the outcomes of their own inquiry. For example, when children try different ways of connecting batteries, bulbs, and wires to produce light, they get feedback directly from the materials they use: the

bulbs may or may not light, or the light may be dim or bright, depending on the materials used and how the parts are connected.

Through inquiry, children acquire concepts in an authentic fashion and can, therefore, be aware of the level of conceptualization they have achieved. For example, in a video documentary on children's classroom science investigations developed by WGBH, a public television station in Boston, Massachusetts, children learned how to test for the presence of sugar in a variety of edible liquids. Contrary to the expectations of one child, milk tested positive when it was checked for sugar. The child knew that the milk came from a cow, and to her knowledge, cows didn't eat sugar! On the basis of this observation, the child surmised that something must have happened inside the cow to introduce sugar into the milk. The child's acquisition of concepts about chemical indicators, and her observation of the results of tests on milk, led her to formulate a further concept about a probable chemical change in the cow.

From their explorations, the children learned a variety of information about the properties of liquids. They learned that the concept of "flow" implies continuity of material and direction of motion; they learned that in many ordinary cases, a liquid is not just one thing, but a combination of substances. As they inquired further, their knowledge base and conceptual understanding about liquids increased. The children could then use these concepts to develop other science concepts. The results of the children's own investigations provided direct feedback to them.

The Many Benefits of Inquiry

When children learn science through inquiry, they communicate their thoughts and ideas through practical action as well as through symbols (i.e., speech, writing, numbers, drawings). With multiple ways of communicating the same information, teachers can have direct and accurate knowledge of each child's level of science learning. It also gives teachers direct knowledge of the child's capacity to successfully carry out inquiry. As a result, teachers are thus better able to help children advance their knowledge of science, science inquiry, and of the nature of doing science.

Inquiry contributes to children's social development, as well as to their intellectual development. Science inquiry in school is carried out in a social context. Children discuss plans and work collaboratively in carrying out inquiry activities. As they work, they keep science notebooks containing written and pictorial records and reflections. They

also prepare themselves and present their work in a public forum to their classmates, who serve as critical friends.

These activities not only foster collaboration among children, they also help develop language and literacy capacity. In addition, inquiry requires children to access written material in order to compare their own "discoveries" with authentic science knowledge. By reading and comprehending this material, children join the larger scientific community on the topics they study.

Conclusion

At first, children's inquiries center on directly observable and often accessible phenomena. Through the processes of asking questions, obtaining answers, attaching meaning to the results of their investigations, and relating the meanings they make to established scientific knowledge, children build a repertoire of knowledge, skills, and habits of mind that affirm their human capacity to productively use inquiry for their development. They also acquire significant science concepts. The interplay between children developing the ability to do inquiry and acquiring the concepts of science—one building upon the other—is indispensable in successful inquiry learning.

When schools adopt an inquiry approach to science education, they also align with children's natural impulses to learn. Science learning thus becomes an extension of the characteristically human approach to knowledge acquisition. It is also an affirmation of a person's capacity to learn, an essential ingredient in every child's wholesome intellectual and cultural development.

Reference

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