

Presentation Handout

Adapted from

Science in Early Childhood: Developing and Acquiring Fundamental Concepts and Skills

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How Fundamental Concepts and Skills Develop

As any scientist knows, the best way to learn science is to do science. This is the only way to get to the business of asking questions, conducting investigations, collecting data, and looking for answers. With young children, this strategy can best be accomplished by examining natural phenomena that can be studied over time. Children need to have a chance to ask and answer questions, do investigations, and learn to apply problem-solving skills. Active, hands-on, child-centered inquiry is at the core of good science experiences.

Concepts are the building blocks of knowledge; they allow people to organize and categorize information. During early childhood, children actively engage in acquiring fundamental concepts and in learning fundamental process skills. As we watch children in their everyday activities at various stages of development, we can observe them constructing and using concepts such as:

- *One-to-one correspondence*—putting pegs in pegboard holes or passing one apple to each child at the table;
- *Counting*—counting the number of straws needed for every child at the table;
- *Classifying*—placing square shapes in one pile and round shapes in another or putting cars in one garage and trucks in another; and
- *Measuring*—pouring sand or water from one container to another.

Children begin to construct many concepts during the early childhood years, including mathematics and science concepts. They also develop the processes that enable them to apply their newly acquired concepts, expand existing concepts, and develop new ones. Concepts used in science grow and develop as early as infancy. *Babies explore the world with their senses.* They look, touch, smell, hear, and taste. Children are born curious and want to know all about their environment. As children learn to crawl, to stand, and to walk, they are free to discover more on their own and learn to think for themselves. They begin to learn ideas of size. As they look about, they sense their relative smallness. They go over, under, and into large objects and discover the size of these objects relative to their own size. They grasp things and find that some fit their tiny hands, and others do not. Infants learn about *weight*: when they cannot always lift items of the same size. They learn about *shape*: Some things stay put while others roll away. They learn *time sequence*: When they wake up, they feel wet and hungry. They cry. The caretaker comes. They are changed and then fed. As babies first look and later move, they discover *space*: Some spaces are big and some spaces are small. With time, babies develop *spatial sense*: They are placed in a crib or playpen in the center of the living room.

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Toddlers sort things: They put them in piles—of the same color, the same size, the same shape, or with the same use. Young children pour sand and water into containers of different sizes. They stack blocks into structures and see them fall and become small parts again. The free exploring and experimentation of a child's first two years help to develop muscle coordination and the senses of taste, smell, sight, and hearing—skills and senses that serve as a basis for future learning.

In preschool and kindergarten, exploration continues to be the first step in dealing with new situations. At this time, however, children also begin to apply basic concepts to *collecting and organizing data* to answer a question. Collecting data requires skills in observation, counting, recording, and organizing. For example, for a science investigation, children might be interested in the process of plant growth. Supplied with lima bean seeds, wet paper towels, and glass jars, the children place the seeds in the jars, securing the seeds to the sides of the jars with the paper towels. Each day they add water, if needed, and observe what is happening to the seeds. They dictate their observation to their teacher, who records their comments on a chart. Each child also plants some beans in dirt in a small container such as a paper or plastic cup. The teacher supplies each child with a chart for his or her bean garden. The children check off each day on their charts until they see a sprout. Then they count how many days it took for a sprout to appear, comparing this number with those of other class members, as well as with the time it takes for the seeds in the glass jars to sprout. The children have used the concepts of number and counting, one-to-one correspondence, time, and comparison of the number of items in two groups.

How Science Concepts Are Acquired

Children acquire fundamental concepts through active involvement with their environment. As they explore their surroundings, they actively construct their own knowledge. Specific learning experiences with young children may be *naturalistic/spontaneous, informal, or structured*. These experiences differ in terms of who controls the activity: the adult or the child. Because there are variations in learning styles among groups of children and among different cultural groups, science content should be introduced when it is appropriate to do so, as illustrated in the following examples.

Naturalistic Experiences are initiated spontaneously by children as they go about their daily activities. The child controls choice and action. These experiences are the major mode of learning for children during the sensorimotor period. Naturalistic experiences are a valuable method of learning even for older children.

With naturalistic experiences, the adult's role is to provide an interesting and rich environment for the child, including many things for the child to look at, touch, taste, smell, and hear. The adult should observe the child's activity, note how it is progressing, and then respond with a glance, a nod, a smile, or a word of praise to encourage the child. The child needs to know when he or she is doing the appropriate things. Below are some examples of naturalistic experiences.

- Tamara takes a spoon from the drawer and says, "This is big." Mom says, "Yes."
- Cindy sits on the rug sorting colored rings into plastic cups.
- Sam is painting. He puts down a dab of yellow. Then he dabs some blue on top. "Hey! I've got green now," he exclaims.

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Informal Learning Experiences are initiated by adults as children are engaged in naturalistic experiences. The child chooses the activity initially, but adults intervene at some point. These experiences are not pre-planned. They occur when the adult's experience or intuition or both indicate that it is time to act. For example, the child might be on the right track in solving a problem but needs a cue or encouragement. In another situation, the adult might take advantage of a teachable moment to reinforce certain concepts. An example of an informal experience follows:

"I'm six years old," says three-year-old Kate while holding up three fingers. Dad says, "Let's count those fingers. One, two, three fingers. You are three years old."

Structured Learning Experiences are planned lessons, activities and experiences that can occur in many different ways. These experiences are chosen by adults who give direction to the child. For example, Cindy is four years old. Her teacher decides that she needs to practice counting. She says, "Cindy, I have some blocks here for you to count. How many are in this pile?"

Teachers and other adults can also offer structured experiences in the following situations:

- With a small group at a specific time. For example, a teacher shows the children balls of different sizes and asks them to examine the balls and discuss their characteristics. The teacher picks up a ball and says, "Find a ball that is smaller."
- At any opportune time. Mrs. Flores, knowing that Tanya needs help with the concept of shape, suggests a game to play and gives her directions to play the game.

Commonalities of Science and Mathematics in Early Childhood

There is a natural integration of concepts and skills across content areas, including mathematics and science. When fundamental mathematics concepts—comparing, classifying, and measuring—are applied to science problems, they are referred to as *process skills*. These mathematical concepts are necessary to solve some science problems. The other science process skills—observing, communicating, inferring, hypothesizing, and defining and controlling variables—are equally important for solving problems in both science and mathematics.

For example, consider the principle of the ramp, a basic concept in physics. Suppose a two-foot-wide board is leaned against a large block, so that it becomes a ramp. Children are given a number of balls of different sizes and weights to roll down the ramp. Once their exploration defines the ideas of the game, the teacher might ask some questions such as, "What would happen if two balls started to roll from the top of the ramp at the same time?" "What would happen if you changed the height of the ramp? Or had two ramps of different heights? Of different lengths?" Children could guess, explore what happens when they vary the steepness and length of the ramps or use different balls, observe what happens, communicate their observations, and describe similarities and differences in each of their experiments. They might observe differences in speed and distance based on the size or weight of the ball, the height and length of the ramp, or other variables. In this example, children would be using mathematical concepts of speed, distance, height, length, and counting, while engaged in scientific observations.

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Math and science concepts and skills can be acquired as children engage in sound early childhood activities such as playing with blocks, water, sand, and manipulative materials, as well as during dramatic play, cooking, and outdoor activities. Providing young children with opportunities to see the math and science in their everyday activities helps them build basic understandings and interest for future learning.

Encouraging Inquiry Through Problem Solving

Research findings overwhelmingly support learning mathematics and science through active learning, inquiry, problem solving, cooperative learning, and other methods that motivate children. Inquiry engages children in the investigative nature of science. Inquiry is behavior that involves activity and skills with the focus on the active search for knowledge or understanding to satisfy curiosity. *Teachers should not expect children to discover everything for themselves*, rather, they should focus on relating new science knowledge both to previously learned knowledge and to experiential learning so children continue to build a consistent picture of the physical world. Teachers facilitate this process in several ways. For example, when children show an interest in learning more about a bean plant or a nearby tree, adults should ask questions to determine what each student already knows. In this way, teachers can modify learning experiences and classroom settings to best meet individual needs.

One way to involve students in inquiry is through problem solving, which is not as much a teaching strategy as it is a child behavior. As with inquiry, the driving force behind problem solving is curiosity—an interest in finding out. The challenge for the teacher is to create an environment in which problem solving can occur.

Problems should relate to, and include, the children's own experiences. From birth, children want to learn and they naturally seek out problems to solve. Problem solving in the pre-kindergarten years focuses on naturalistic and informal learning: filling and emptying containers of water, sand, or other substances; observing ants; or racing toy cars down a ramp. In kindergarten and the primary grades, adults can institute a more structured approach to problem solving.

Problem solving can be a powerful motivating factor to learn science. When children perceive the situations and problems they experience as real, their curiosity inspires them to find answers. Searching for a solution to a question or problem that is important to a child, holds attention and creates enthusiasm for learning.

However, mismatching content and developmental levels (e.g., expecting young children to understand the movements of the Earth's crust) leads to misconceptions and frustrations for teacher, parent, and child. These types of mismatches often cause teachers to resort to telling the information in a didactic manner because the child cannot conceptualize the content. The results of mismatched content and cognitive capacity are: (1) children are unable to extend, apply, or interpret deeper meanings of the content; and (2) interest and positive attitudes toward science are likely to diminish. *The implication from research is that content must always be within the realm of possibility of comprehension.*

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