Science as Inquiry

A Playground Curriculum of Exploration

Scientific Process Overview & Playground Standards

Preface

The Sherwood Forest curriculum for developing scientific understandings and inviting children to be self-directed learners borrows heavily from the work of Jean Piaget and couples it with the National Science Foundation's, *National Science Education Standards.* Sherwood's content focus emphasizes scientific inquiry, biology, and the Earth sciences.

Jean Piaget was born in Neuchâtel (Switzerland) on August 9, 1896. He died in Geneva on September 16, 1980. During his brilliant scientific career he authored over sixty books and several hundred articles.

Successively or simultaneously, Piaget occupied several chairs: psychology, sociology and history of science at Neuchâtel from 1925 to 1929; history of scientific thinking at Geneva from 1929 to 1939; the International Bureau of Education from 1929 to 1967; psychology and sociology at Lausanne from 1938 to 1951; sociology at Geneva from 1939 to 1952, then genetic and experimental psychology from 1940 to 1971. He was, reportedly, the only Swiss to be invited at the Sorbonne from 1952 to 1963. In 1955, he created and directed until his death the International Center for Genetic Epistemology. His research in developmental psychology and genetic epistemology had one unique goal: how does knowledge grow? His answer is that the growth of knowledge is a progressive construction of logically embedded structures superseding one another by a process of inclusion of lower less powerful logical means into higher and more powerful ones up to adulthood. Therefore, children's logic and modes of thinking are initially entirely different from those of adults.

Piaget's oeuvre is known all over the world and is still an inspiration in fields like psychology, sociology, education, epistemology, economics and law as witnessed in the annual catalogues of the Jean Piaget Archives. He was awarded numerous prizes and honorary degrees all over the world.

In Sherwood's Playground and Nature Program, Piaget's work in developmental psychology, the growth of knowledge, children's logic, and modes of thinking is applied to their investigation of the natural world.

Jean Piaget with his family, circa 1930

Developing understanding & ability to be a self-directed learner

From the earliest years, children should experience science in a form that engages them in the active construction of ideas and explanations that enhance their opportunities to develop the abilities of *doing* science. Students should *do* science in ways that are within their developmental capabilities. This standard sets forth some abilities of scientific inquiry appropriate for Sherwood's Playgrounders.

In the Playground, campers investigate earth materials, organisms, and properties of common objects. Although children develop concepts and vocabulary from such experiences, they also should develop inquiry skills. As Playgrounders focus on the processes of doing investigations, they develop the ability to ask scientific questions, investigate aspects of the world around them, and use their observations to construct reasonable explanations for the questions posed. Guided by counselors, Playgrounders continually develop their science knowledge. Playgrounders should also learn through the inquiry process how to communicate about their own and their peers' investigations and explanations.

There is logic behind the abilities outlined in the Playground inquiry standard, but a step-by-step sequence or scientific method is not implied. In practice, Playgrounders questions might arise from previous investigations, planned activities, or questions Playgrounders ask each other. For instance, if children ask each other how animals are similar and different, an investigation might arise into characteristics of organisms they can observe.

Full inquiry involves asking a simple question, completing an investigation, answering the question, and presenting the results to others. In the Playground, students begin to develop the physical and intellectual abilities of scientific inquiry. With the help of adults serving as *coaches*, they can design investigations to try things to see what happens - they tend to focus on concrete results of tests and will entertain the idea of a "fair" test (a test in which only one variable at a time is changed).

Underlying fundamental abilities and concepts

Ask a question about objects, organisms, and events in the environment (their surroundings).

This aspect emphasizes Playgrounders asking questions that they can answer with scientific knowledge, combined with their own observations. Playgrounders should answer questions by seeking information from reliable sources of scientific information and from their own observations and investigations.

Plan and conduct a simple investigation.

In the earliest years, investigations are largely based on systematic observations. As Playgrounders develop, they may design and conduct simple experiments to answer questions. The idea of a fair test is possible with coaching from counselors.

Employ simple equipment & tools to gather data & extend the senses.

In early years, Playgrounders develop simple skills, such as how to observe, measure, cut, connect, switch, turn on and off, pour, hold, tie, and hook. Beginning with simple instruments, students can use rulers to measure the length, height, and depth of objects and materials; thermometers to measure temperature; watches to measure time; spring scales to measure weight; magnifiers to observe objects and organisms; and microscopes to observe the finer details of plants, animals, rocks, and other materials.

Use investigation results & direct observations to construct a reasonable explanation.

This aspect of the standard emphasizes the Playgrounders' thinking as they use observations and results from investigations to formulate explanations. Even at the earliest years, Playgrounders should learn what constitutes evidence and judge the merits or strength of the information that will be used to make explanations. After Playgrounders propose an explanation, they will appeal to the knowledge and evidence they obtained to support their explanations.

Communicate investigations & explanations

Playgrounders begin developing the abilities to communicate, critique, and analyze their work and the work of other students. This communication might be spoken or drawn.

Understandings about scientific inquiry

Scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world.

Scientists use different kinds of investigations depending on the questions they are trying to answer. Types of investigations include describing objects, events, and organisms; classifying them; and doing a fair test (experimenting).

Simple instruments, such as magnifiers, thermometers, and rulers, provide more information than scientists obtain using only their senses.

Scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge). Good explanations are based on evidence from investigations.

Scientists make the results of their investigations public; they describe the investigations in ways that enable others to repeat the investigations.

Scientists review and ask questions about the results of other scientists' work.
Physical Science

Scientific Content Overview & Playground Standards

Develop an understanding of properties of objects and materials

During their early years, children's natural curiosity leads them to explore the world by observing and manipulating common objects and materials in their environment. Children compare, describe, and sort as they begin to form explanations of the world. Developing a subject-matter knowledge base to explain and predict the world requires many experiences over a long period. Young children bring experiences, understanding, and ideas to school; counselors provide opportunities to continue children's explorations in focused settings with other children using simple tools, such as magnifiers and measuring devices.

Through the observation, manipulation, and classification of common objects, children reflect on the similarities and differences of the objects. As a result, their initial sketches and single-word descriptions lead to increasingly more detailed drawings and richer verbal descriptions.

Young children begin their study of the physical world by examining and qualitatively describing objects and their behavior. The important but abstract ideas of science, such as atomic structure of matter and the conservation of energy, all begin with observing and keeping track of the way the world behaves. When carefully observed, described, and measured, the properties of objects, changes in properties over time, and the changes that occur when materials interact provide the necessary precursors to the later introduction of more abstract ideas when they are older.

Sounds are not intuitively associated with the characteristics of their source by younger Playgrounders, but that association can be developed by investigating a variety of concrete phenomena toward that end.

Develop an understanding of organisms, life cycles, & environments

Young children build understanding of biological concepts through direct experience with living things, their life cycles, and their habitats. These experiences emerge from the sense of wonder and natural interests of children who ask questions such as: "How do plants get food? How many different animals are there? Why do some animals eat other animals? What is the largest plant? Where did the dinosaurs go?" An understanding of the characteristics of organisms, life cycles of organisms, and of the complex interactions among all components of the natural environment begins with questions such as these and an understanding of how individual organisms maintain and continue life.

Making sense of the way organisms live in their environments will develop some understanding of the diversity of life and how all living organisms depend on the living and nonliving environment for survival. Because the child's world while at the Playground is closely associated with the home, community, and immediate environment,

the study of organisms should include observations and interactions within the natural world of the child. The experiences and activities in the Playground provide a concrete foundation for the progressive development in the later grades of major biological concepts, such as the cell, the biosphere, interdependence, the behavior of organisms, and matter and energy in living systems.

Children's ideas about the characteristics of organisms develop from basic concepts of living and nonliving. Piaget noted, for instance, that young children give anthropomorphic explanations to organisms. In the early years, many children associate "life" with any objects that are active in any way. This view of life develops into one in which movement becomes the defining characteristic. Eventually children incorporate other concepts, such as eating, breathing, and reproducing to define life. As Playgrounders have a variety of experiences with organisms, and subsequently develop a knowledge base in the life sciences, their anthropomorphic attributions decline.

Activities such as classification, younger elementary students generally use mutually exclusive rather than hierarchical categories. Young children, for example, will use two groups, but older children will use several groups at the same time. Playgrounders do not consistently use classification schemes similar to those used by biologists until the older years.

As Playgrounders investigate the life cycles of organisms, counselors might observe that young children do not understand the continuity of life from, for example, seed to seedling or larvae to pupae to adult. But, counselors will notice that by Novice, most students know that children resemble their parents. Novice can also differentiate learned from inherited characteristics. However, these young children might hold some naive thoughts about inheritance, including the belief that traits are inherited from only one parent, that certain traits are inherited exclusively from one parent or the other, or that all traits are simply a blend of characteristics from each parent.

Playgrounders think concretely about individual organisms. For example, animals are associated with pets or with animals kept in a zoo. The idea that organisms depend on their environment (including other organisms in some cases) is not well developed in young children. At the Playground, the focus should be on establishing the primary association of organisms with their environments and the secondary ideas of dependence on various aspects of the environment and of behaviors that help various animals survive. Playgrounders can understand the food link between two organisms.

Understandings about the characteristics of organisms

Organisms have basic needs. For example, animals need air, water, and food; plants require air, water, nutrients, and light.

Organisms can survive only in environments in which their needs can be met. The world has many different environments, and distinct environments support the life of different types of organisms.

Each plant or animal has different structures that serve different functions in growth, survival, and reproduction. For example, humans have distinct body structures for walking, holding, seeing, and talking.

The behavior of individual organisms is influenced by internal cues (such as hunger) and by external cues (such as a change in the environment). Humans and other organisms have senses that help them detect internal and external cues.

Understandings about the life cycles of organisms

Plants and animals have life cycles that include being born, developing into adults, reproducing, and eventually dying. The details of this life cycle are different for different organisms.

Plants and animals closely resemble their parents.

Many characteristics of an organism are inherited from the parents of the organism, but other characteristics result from an individual's interactions with the environment.

Inherited characteristics include the color of flowers and the number of limbs of an animal. Other features, such as the ability to ride a bicycle, are learned through interactions with the environment and cannot be passed on to the next generation.

Understandings about organisms & their environments

All animals depend on plants. Some animals eat plants for food. Other animals eat animals that eat the plants.

An organism's patterns of behavior are related to the nature of that organism's environment, including the kinds and numbers of other organisms present, the availability of food and resources, and the physical characteristics of the environment.

When the environment changes, some plants and animals survive and reproduce, and others die or move to new locations.

All organisms cause changes in the environment where they live. Some of these changes are detrimental to the organism or other organisms, whereas others are beneficial.

Humans depend on their natural and constructed environments. Humans change environments in ways that can be either beneficial or detrimental for themselves and other organisms.

Develop an understanding of properties of the Earth & sky

Playgrounders are naturally interested in everything they see around them - soil, rocks, streams, rain, clouds, rainbows, sun, moon, and stars. During the first years of Camp,

they should be encouraged to observe closely the objects and materials in their environment, note their properties, distinguish one from another and develop their own explanations of how things become the way they are. As children become more familiar with their world, they can be guided to observe changes, including cyclic changes, such as night and day and the seasons; predictable trends, such as growth and decay, and less consistent changes, such as weather or the appearance of meteors. Children should have opportunities to observe rapid changes, such as the movement of water in a stream, as well as gradual changes, such as the erosion of soil and the change of the seasons.

Children come to the Playground aware that earth's surface is composed of rocks, soils, water, and living organisms, but a closer look will help them identify many additional properties of earth materials. By carefully observing and describing the properties of many rocks, children will begin to see that some rocks are made of a single substance, but most are made of several substances. In later years, the substances can be identified as minerals. Understanding rocks and minerals should not be extended to the study of the source of the rocks, such as sedimentary, igneous, and metamorphic, because the origin of rocks and minerals has little meaning to young children.

The Playground, forest, and beach are convenient study sites to observe a variety of earth materials. As students collect rocks and observe vegetation, they will become aware that soil varies from place to place in its color, texture, and reaction to water. By planting seeds in a variety of soil samples, they can compare the effect of different soils on plant growth. If they revisit study sites regularly, children will develop an understanding that earth's surface is constantly changing. They also can simulate some changes, such as erosion, while playing at the beach and then compare their observations with similar, but larger scale, erosive changes throughout the Forest.

By observing the day and night sky regularly, young children learn to identify sequences of changes and to look for patterns in these changes. As they observe changes, such as the movement of an object's shadow during the course of a day, and the positions of the sun and the moon, they will find the patterns in these movements. They can draw the moon's shape for each evening on a calendar and then determine the pattern in the shapes over several weeks. These understandings should be confined to observations, descriptions, and finding patterns. Attempting to extend this understanding into explanations using models will be limited by the inability of young children to understand that earth is approximately spherical. They also have little understanding of gravity and usually have misconceptions about the properties of light that allow us to see objects such as the moon. (Although children will say that they live on a ball, probing questions will reveal that their thinking may be very different.)

Students can discover patterns of weather changes during the summer. Playgrounders can draw a daily weather picture based on what they see at the Playground. Emphasis should be on developing observation and description skills and the explanations based on observations. Playgrounders should be encouraged to talk about and draw what they see and think.

Understandings about the Earth materials

Earth materials are solid rocks and soils, water, and the gases of the atmosphere.

The varied materials have different physical and chemical properties, which make them useful in different ways, for example, as building materials, as sources of fuel, or for growing the plants we use as food.

Earth materials provide many of the resources that humans use.

Soils have properties of color and texture, capacity to retain water, and ability to support the growth of many kinds of plants, including those in our food supply.

Fossils provide evidence about the plants and animals that lived long ago and the nature of the environment at that time.

Understandings about objects in the sky

The sun, moon, stars, clouds, birds, and airplanes all have properties, locations, and movements that can be observed and described.

The sun provides the light and heat necessary to maintain the temperature of the earth.

Understandings about changes in the Earth & sky

The surface of the earth changes. Some changes are due to slow processes, such as erosion and weathering, and some changes are due to rapid processes, such as landslides, volcanic eruptions, and earthquakes.

Weather changes from day to day and over the seasons.

Weather can be described by measurable quantities, such as temperature, wind direction and speed, and precipitation.

Objects in the sky have patterns of movement. The sun, for example, appears to move across the sky in the same way every day, but its path changes slowly over the seasons.

The moon moves across the sky on a daily basis much like the sun. The observable shape of the moon changes from day to day in a cycle that lasts about a month.