Science

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FOUNDATIONS FOR SCIENCE

"The exploration of the natural world is the stuff of childhood. Science, when viewed as a process of constructing understanding and developing ideas, is a natural focus of in an early childhood program. As children are given opportunities to engage in inquiry of phenomena, they develop many cognitive skills. It is also the context in which children can develop and practice many basic skills of literacy and mathematics. Finally, science is a collaborative endeavor in which working together and discussing ideas are central to the practice." Worth, 2010

Infants and young children are natural scientists, but they must have guidance and structure to expand their curiosity and activity into something more scientific – to practice science.
The goal of science curricula is to help children understand the natural world through a process known as scientific inquiry. As children investigate, they acquire knowledge that explains the world around them, for instance, why snow or ice melts. Scientific knowledge helps us predict what might happen, help us solve problems, and create expanded technologies to serve our needs.

Worth and Grollman, 2003, introduced a simple inquiry learning cycle to guide early childhood educators as they facilitate children investigations. This cycle begins with providing extended periods of time for children to engage and explore selected phenomenon and materials – discovering what they can do, wonder about them, share ideas, and raise questions - (describe, identify patterns, record observations using words, pictures, charts, and graphs). The cycle then extends to a more facilitated state as questions are identified that might be investigated further.

Beginning at birth, babies use all of their senses in their efforts to understand and organize their environment and experiences. Through multi-sensory, firsthand, spontaneous, and repeated observations and direct experiences with materials, processes, and other people, babies gradually begin to formulate an understanding of what the world is, how it works, and their own place in it. This understanding will change over and over as the young child uses evidence gained from experiences much like the scientist supports or disproves a theory.

Through early science experiences, children:

- **Develop trust in other people and a sense of personal effectiveness.**
- **Express and display confidence in themselves and in their environment.**
- **Gain necessary, firsthand experiences with objects and other people that help to develop sensory, physical, emotional, intellectual, and social attributes and verify information.**
- **Develop and apply basic concepts about physical and social environments (properties of objects and people).**
- **Increase and demonstrate observation skills.**
- **Use tools, equipment, and familiar materials.**
- **Display problem solving with adult scaffolding.**
- **Explore and discover to increase basic knowledge.**
- **Receive opportunities to use their senses and curiosity to explore their environment.**
- **Use their bodies and materials found in everyday settings to act on objects.**
- **Increase vocabulary and ask and answer questions.**
- **Are supported by adults to explore, wonder, reason, and solve problems.**

KEY FINDINGS

- **Children gain when they have "opportunities to engage in in-depth investigations of phenomena around them worthy of their knowledge and understanding".** (Katz, 2010)
- **Young children are sophisticated thinkers and adults often underestimate what they can do and think about.** (SEED conference, 2010)
- **Young children are constantly engaged in making meaning of their worlds.** (SEED conference, 2010)
- **Children's direct experience is the key to their learning.** (SEED conference, 2010)
- **Engaging in science experiences is a natural and critical part of children's early learning.** (SEED conference, 2010)
- **Children's curiosity about the natural world is a powerful catalyst for their work and play.** (SEED conference, 2010)
- **When children are nurtured to act on their curiosity and need to make sense of the world, this becomes the foundation for the beginning use of skills of inquiry to explore basic phenomena and materials.**
- **Early childhood science curricula is a rich context in which children can use and develop other important skills, e.g. working together with peers, basic large and small motor control, language and early mathematical understanding.**

GLOSSARY:

Science: Knowledge of the physical or material world gained through observation and experimentation.

RESOURCES AND REFERENCES

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SCIENCE Standard Area

- **COMMON CORE STATE STANDARD: NONE**
  Indiana Academic Standards for Science can be found here:
  http://dc.doe.in.gov/Standards/AcademicStandards/PrintLibrary/docs-science/2006-science-grade0k.pdf
- **ISTAR-KR:** English/Language Arts; Comprehension, Receptive & Expressive Language
  Math – Computation, Length/Size/Weight/Temperature
  Social Emotional – Problem Solving
  Physical – Sensory Integration

Infants, toddlers and preschoolers are active explorers. They are able to learn about their environments through their senses, such as listening, hearing, touching, and hands-on experiences.

Intellectual curiosity is considered 'the very source' of science, because science activities provide opportunities for both learning and development (Hadzigeorgiou, 2001). Young children enjoy hands-on experiences with objects and materials. These early science experiences are fun for children and benefit all areas of their development. Both novel and familiar activities build concepts that can be used throughout life.

Young Children are Learning When They:

SC.1.1 Search and respond to sound and voice.
SC.1.2 Focus eyes on small objects and reach for them.
SC.1.3 Interact with and explore a variety of objects, books, and materials.
SC.1.4 Make representative drawings of familiar objects and people.
SC.1.5 Identify, copy, extend, and create patterns with objects and in drawings.
SC.1.6 Dictate statements/draw pictures to share findings.
SC.1.7 Use charts, drawings, and/or graphs to share their findings with others.
SC.1.8 Use their findings to create self-published books and/or materials.
SC.1.9 Communicate discoveries.

A child can be supported by an adult who:

- Talks to the infant about things he is interested in, things he is doing, and things the adult is doing.
- Extends the toddler's thinking and learning by imposing problems, making suggestions, responding to and encouraging the toddler's questions.
- Encourages the toddler to represent discoveries and ideas through a variety of ways (e.g., drawings, photos, discussions, pretending).
- Plays patty cake, peek-a-boo, and hide and seek.
- Allows lots of time to work on problems—doesn't offer help too soon (e.g., offer toys with moving parts).

Young Children are Learning When They:

SC.1.10 Express ideas and share observations with others.
SC.1.11 Observe and describe properties of objects.
SC.1.12 Hold a crayon or marker and scribble.
SC.1.13 Seek interaction and enjoy social play (e.g., patty cake).
SC.1.14 Listens to others' conversations.
SC.1.15 Ask and answer simple questions.
SC.1.16 Imitate something heard or seen earlier in the day (delayed imitation).
SC.1.17 Label and describe familiar objects.
SC.1.18 Use words to describe physical attributes of objects (e.g., size, color).
SC.1.19 Ask and answer questions about his world.
SC.1.20 Manipulate a variety of objects and tell about what is observed (e.g., more than, less than, equal to/same).
SC.1.21 Talk about the fact that everything has a shape.
SC.1.22 Investigate and talk about the characteristics of matter (e.g., liquids and solids, smooth and rough, bend-not bend).
SC.1.23 Describe differences and similarities in various physical environments.
SC.1.24 Ask questions and/or make comments about the sun, stars, planets, and clouds.
SC.1.25 Describe how the physical environment affects the living environment and vice versa.
SC.1.26 Identify plants and animals as living things.
SC.1.27 Identify non-living things.

A child can be supported by an adult who:

- Talks clearly and calmly with the child about what they are doing.
- Imitates and encourages the child's attempts to make sounds or says words.
- Provides opportunities in and out of the classroom for children to explore objects and materials.
- Provides familiar materials to measure things (e.g., popsicle sticks, paper clips, crayons, unifix cubes, hands).
- Asks the child to look for and name shapes within and outside the classroom.
- Provides opportunities for the child to create his/her own patterns for others to follow and/or extend patterns by using leaves, rocks, nuts, etc.
- Involves the child in experiences with changes of matter (e.g., cooking, mixing things together, dissolving things in liquids).
- Provides a variety of objects for the child to sort, classify, and/or match.
- Uses the language and terms associated with physical science (e.g., fulcrum, force, weight, balance, gravity).

How it looks in everyday activities:

Logan and Emma whispered excitedly to each other as they watched Mrs. Glen bring out a large bowl of ice. Mrs. Glen said, "Boys and girls, here are some tongs, spoons, containers of warm and cool water and lots of other things. You can use all of these materials to experiment with ice and water today."

The children could hardly wait to start trying out different activities with the materials! Logan started dropping ice pieces into different containers of water, watching the water splash each time.

Emma found a big wooden spoon and stirred the ice in the large bowl, enjoying the crashing noises and the sight of the ice pieces flying up and out of the bowl. As she stirred, Emma noticed something. "Hey Logan!" she said, "The ice in the big bowl is turning to water!" "Yeah," Logan added, "It melts when it gets warm." Emma saw a large eye dropper and found that she could suck the water from around the cubes and then squeeze it back into the bowl or another container. Logan came nearer and watched Emma, saying "I want a turn with that next."

Mrs. Glen watched Emma working and Logan watching. She knew that Logan, who has some difficulty with fine motor tasks, would be frustrated with the eye dropper. "Logan, why don't you help Emma get the water out?" she asked. "You can use one of these," she added showing him a baster and a small ladle. The children worked together to clear the melted ice from the bowl.

Development of a skill in one area is related to and influences other developmental areas:

Social/Emotional:
- Children playing side-by-side.
- Works cooperatively.

Physical:
- Uses small motor skills in picking up objects

Communication/Literacy:
- Communicates with peer.

Self-Help:
- Experiences cold sensation.

Young Children are Learning When They:

SC.1.28 Use vocabulary that indicates understanding of scientific principles (e.g., sink, float, melt, solid, liquid).

SC.1.29 Classify objects by an attribute (characteristic) and share their thinking with another.

SC.1.30 Participate in discussions related to their findings.

SC.1.31 Participate in activities related to number sequencing and counting.

SC.1.32 Use age appropriate scientific equipment (e.g., magnifying glasses, thermometer, scales) when participating in scientific experiences.

SC.1.33 Manipulate a variety of objects and tell about what is observed (e.g., more than, less than, equal to/same).

SC.1.34 Manipulate objects.

SC.1.35 Get inside things to explore.

SC.1.36 Follow a moving object or person with eyes.

A child can be supported by an adult who:

- Follows a child's lead.
- Allows the child to explore, manipulate, and problem solve with ample time for practice and repetition.
- Provides sensory materials and experiences that are interesting and stimulating.
- Promotes exploration by being available, aware of safety issues, and responsive to their cues.
- Provides reassurances and serves as a positive, exploring role model.
- Scaffolds: Notices what the infant is doing and then provides just enough assistance to facilitate continued learning.
- Sets up experiments for toddlers (e.g., ice in the water table with other objects such as food coloring, plastic hammers).
- Provides objects that are fun to poke, squeeze, manipulate, with different textures, shapes, and sizes.
- Provides tools and toys for the child to use when exploring the environment (e.g., buckets, shovels, water).
- Provides experiences related to the study of earth materials, patterns, and change (e.g., water, rocks, dirt, snow).

Young Children are Learning When They:

SC.1.37 Use their five senses to learn about the environment.
SC.1.38 Identify hot and cold in the environment.
SC.1.39 Identify sun and rain in the environment.
SC.1.40 Use a variety of "scientific tools" (e.g., balance scales, magnifying glasses, measuring cups, food coloring) to investigate the environment and to gather information.
SC.1.41 Use familiar materials to measure things (e.g., popsicle sticks, unifix cubes, paper clips, crayons, hand).
SC.1.42 Investigate the physical surroundings by digging in dirt, collecting and classifying rocks, recognizing changes in weather.
SC.1.43 Gain a natural sense of the forces of nature by experiencing wind blowing, temperature changes, changing seasons of the year, or things falling.
SC.1.44 Look at things within the environment.
SC.1.45 Explore objects by touching, shaking, banging, and mouthing.
SC.1.46 Enjoy filling and dumping activities.
SC.1.47 Explore objects with various properties (e.g., color, sound, texture, shape).
SC.1.48 Sort and match objects by more than one attribute.
SC.1.49 Classify objects by different attributes (characteristics).
SC.1.50 Observe shapes and look for objects that are the same shape.
SC.1.51 Observe and describe properties of objects.
SC.1.52 Participate in activities using materials with a variety of shapes and patterns.
SC.1.53 Participate in activities using materials with a variety of properties (e.g., color, shape, size, name, type of material).

A child can be supported by an adult who:

- Scaffolds the child's learning by breaking down tasks into steps and reminding of the next step by giving indirect suggestions rather than giving the answer.
- Provides materials of appropriate and safe size for sorting (e.g., colored blocks) and something to sort them into (e.g., muffin tin).
- Extends the child's thinking and learning by posing problems, making suggestions, responding to and encouraging the child's questions, and adding complexity to tasks.
- Extends the child's learning by allowing the child to make predictions.
- Encourages the child to document discoveries through a variety of ways (e.g., drawings, photos, discussions, graphing).
- Uses language associated with science (e.g., hypothesis, prediction, conclusion, experiment, science, investigation).
- Discusses with the child the schedule for the day using language such as before/after.
- Organizes the environment to support and encourage counting/sorting.
- Utilizes mathematical language whenever possible, specifying the number of objects being needed or discussed.
- Counts with the child while moving to music or while using body rhythms (e.g., clapping and stomping).
- Provides familiar materials to measure things (e.g., popsicle sticks, paper clips, crayons, unifix cubes, hands).
- Assists the child in recording observations and results of scientific investigations.
- Creates simple visual patterns using children (e.g., boy-girl, stand-sit).
- Has the child recreate patterns using lacing beads, colored pasta, peg boards, poker chips, or other manipulatives.
- Asks the child to look for patterns in and out of the classroom or on clothing.

How it looks in everyday activities:

Abby, age 22 months, visits her grandmother with some cousins. The cousins, who are older, go outside to fish in the creek. Abby reaches up to Grandma and says, "Water." "Are you thirsty?" asks Grandma, picking her up and walking to the cabinet. "Here's a cup, let's get a drink." Abby looks out of the window where she can see the cousins with fishing rods standing near the creek. She points outside and says again, "Water." Grandma follows Abby's look. "Oh you want to go outside to the big water," she says as she carries Abby outside. Abby smiles, satisfied, and repeats "big water" several times. Outside, Elise shows Abby a small fish. Abby's eyes are wide and she holds tight to Grandma. Elise says, "It's just a fish! See? We're gonna let it go back to the water." Abby gets down and walks nearer the water. She looks down at the water where the fish disappeared and quietly says "Ish. Water. Big water."

Development of a skill in one area is related to and influences other developmental areas:

Social/Emotional:

- Holds grandmother when frightened.
- Attends to activities of others.

Physical:

- Walks; reaches; adjusts when carried.

Communication/Literacy:

- Uses pointing to communicate.
- Uses words to make a request and comment.
- Repeats what others say.

Self-Help:

- Persists in getting needs met.

Young Children are Learning When They:

SC.1.54 Investigate and talk about the characteristics of matter (e.g., liquids and solids, smooth and rough, bend-not bend).

SC.1.55 Sort things by attribute or characteristic.

SC.1.56 Compare characteristics of living things (e.g., Donkeys have shorter legs and longer ears than horses; a tulip looks like just a cup, but a daffodil looks like a cup and saucer).

A child can be supported by an adult who:

- Provides opportunities for the child to create his/her own patterns for others to follow and/or extend patterns by using leaves, rocks, nuts, etc.
- Exposes the child to the concept of balance using blocks, teeter-totter, balance scales, etc.
- Provides an area for science exploration with a variety of available materials (e.g., boards and boxes, levers, wheels and axles, pendulums, and pulleys).
- Provides a variety of objects for the child to sort, classify, and/or match.
- Integrates science into other areas and activities in the classroom (e.g., math, reading, writing, art, music, movement).
- Makes available materials necessary to record findings (e.g., paper, markers, clip boards).
- Plans nature walks to observe, to listen, and to collect.
- Assists the child as he describes his discoveries and/or records his observations or findings through drawings, charts, graphs, etc.
- Provides a variety of objects and opportunities for comparing and sequencing.
- Provides materials needed for the sharing of findings (e.g., paper, glue, scissors, markers, camera, blank books).

Young Children are Learning When They:

SC.1.57 Recognize and discriminate the sight, smell, and sound of the principal caregiver.
SC.1.58 Predict reactions from others (e.g., pulling hair).
SC.1.59 Show fear of falling off of a high place.
SC.1.60 Resist separation and seek reassurance from trusted caregiver when encountering an unfamiliar person or object.
SC.1.61 Repeat a behavior that had previously caused a desired effect.
SC.1.62 Resist adult's direction or agenda by testing limits.
SC.1.63 Cry to express displeasure.
SC.1.64 Experiment with likes and dislikes of caregivers and other children (e.g., pulling hair).
SC.1.65 Express ideas and share observations with others.
SC.1.66 Seek interaction and enjoy social play (e.g., patty cake).
SC.1.67 Enjoy simple pretend play.
SC.1.68 Get into everything and require constant supervision.
SC.1.69 Talk to self to solve problems.
SC.1.70 Engage in a scientific experiment with a peer or with small groups of children using sharing/turn taking skills.
SC.1.71 Show curiosity in objects and sounds.
SC.1.72 Apply previously learned information to new situations.

A child can be supported by an adult who:

- Follows a child's lead.
- Allows the child to explore, manipulate, and problem solve with ample time for practice and repetition.
- Talks to the child about things he is interested in, things he is doing, and things the adult is doing.
- Promotes exploration by being available, aware of safety issues, and responsive to their cues.
- Provides reassurances and serves as a positive, exploring role model.
- Scaffolds: Notices what the child is doing and then provides just enough assistance to facilitate continued learning.
- Extends thinking and learning by imposing problems, making suggestions, responding to and encouraging questions.
- Offers choices ("which shirt will you wear today?") to support growing need for independence.
- Has a regular, daily routine that builds the ability to predict events.
- Supports the child's beginning friendships by providing opportunities for the child to learn and explore with peers and adults

Young Children are Learning When They:

SC.1.73 Use their five senses to learn about the environment.
SC.1.74 Follow objects.
SC.1.75 Look for a toy that has rolled out of sight.
SC.1.76 Actively explore simple machines (e.g., pulleys, levers, wheels).
SC.1.77 Anticipate and navigate around environmental barriers.
SC.1.78 Push or pull objects while walking.
SC.1.79 Manipulate objects.
SC.1.80 Activate simple machines or cause and effect toys; take toys apart.
SC.1.81 Interact with and explore a variety of objects, books, and materials.
SC.1.82 Move from primarily reflex actions to doing things on purpose.

A child can be supported by an adult who:

- Provides sensory materials and experiences that are interesting and stimulating.
- Promotes exploration by being available, aware of safety issues, and responsive to their cues.
- Encourages exploration by imitating the infant's actions.
- Sets up experiments for toddlers (e.g., ice in the water table with other objects such as food coloring, plastic hammers).
- Provides containers that can be opened and closed, nested, or smaller objects that can be dropped into larger ones.
- Encourages riding toys to gain sense of self in space.
- Takes child on walks or rides, describing what they see.
- Allows the child to experience the consequences of actions (when safe). Then talk about what happened and why.
- Provides materials of appropriate and safe size for sorting (e.g., colored blocks) and something to sort them into (e.g., muffin tin).
- Encourages and supports opportunities for children to plan and select science related activities.

How it looks in everyday activities:

Water Droplet Trails

Susan, Juan, and Mrs. Hunt are watching the rain hit the windows. "Look how the water drops get longer as they move down the window," Mrs. Hunt says. Susan traces the drop and says, "It looks like a little worm moving around."

Mrs. Hunt says, "I have an idea to have some fun with some water drops." She brings out several Styrofoam plates and some permanent markers. "Draw a small circle, a little smaller than a dime," she says. "Next, make different lines to connect the circles, like a straight line, or wavy line." Juan draws a jagged line and Susan makes a curvy line on her plate.

Mrs. Hunt uses an eyedropper to fill up one circle with water. She carefully tilts her plate so that the water runs along the line from one circle to the other. Both children fill a circle and watch the water move along the lines. Susan uses a small sponge to fill her circle because the eyedropper is hard for her to use. "I want to do it again," Susan says. "Here," Juan says, "just dry the plate with this paper towel and then start over."

Development of a skill in one area is related to and influences other developmental areas:

Social/Emotional:

- Demonstrates interest and participates in classroom activities.
- Seeks out children and adults.
- Works cooperatively and accepts responsibility.
- Shares materials.

Cognitive:

- Explores objects and environments.
- Observes and makes discoveries.
- Follows simple directions.
- Identifies names of objects.
- Increases vocabulary.
- Makes comparisons.
- Displays awareness of cause-and-effect relationships.
- Identifies relationships of objects in space.
- Shows curiosity and desire to learn.

Physical*:*

- Coordinates eye and hand movements.
- Uses small muscles to complete tasks.
- Demonstrates visual discrimination skills.

Self-help:

- Uses planning skills.
- Shows responsibility for helping to maintain the environment.
- Demonstrates increasing independence.

Communication/Literacy:

- Uses words to describe the characteristics of objects.
- Participates in group discussions.
- Asks and responds to questions.
- Uses words to explain ideas and feelings.