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An Online Resource for Ohio Educators

Early Childhood Building Blocks

Turning Curiosity into Scientific Inquiry

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INTRODUCTION

Children are naturally curious, and why shouldn't they be? Their world is an exciting place, filled with new things to explore, new sights to see, and new people to meet. If we can harness that curiosity and turn it into inquiry, we can fuel their excitement, extend their learning, and help them develop vital thinking strategies.

What's Inside

RATIONALE

Curiosity is the desire to know about something, but just wondering and being curious does not provide children with knowledge. Knowledge comes when curious children have answers. How do children get answers? The best answers come when curious children find the answers themselves through inquiry.

What is inquiry? Very briefly, inquiry is a way of teaching that encourages children to learn by exploring ideas and asking questions. Inquiry is also a way of learning—a thinking and hands-on process that involves children in solving problems and discovering how things work.

Research shows that children who learn how to appropriately inquire are more actively engaged in their learning, have greater language skills, and develop more positive social interactions (Conezio & French, 2002). In addition, inquiry helps children to create "habits of mind" (Dyasi, 2000) that transfer to other learning experiences beyond the science classroom. Scientific inquiry involves focusing on an object or event of interest and then observing, experimenting, and/or analyzing it in order to understand it.

The National Science Education Standards emphasize that inquiry is just one of the instructional strategies that teachers should use to teach science, not the only instructional strategy (Olson & Loucks-Horsley, 2000). That being said, the inquiry process and the skills needed to do inquiry should be central to any science program.

> **"Inquiry is a way of teaching that encourages children to learn by exploring ideas and asking questions."**

ENCOURAGING INQUIRY

Although curiosity and exploratory play come naturally to children, inquiry does not. For one to blossom into the other, teachers and others need to intentionally support children as they explore the world. Teachers can encourage the inquiry process as they:

- Build a foundation of inquiry skills
- Model inquiry skills and language
- Offer a variety of learning experiences

Building a foundation for inquiry includes developing and reinforcing students' process skills, such as observing, questioning, communicating, and working with others. One way to accomplish this is to have a learning environment filled with materials that support inquiry. Tools such as magnifying glasses and bug boxes invite observation, while poster paper, crayons, and even digital cameras offer ways for students to communicate and share their findings. Students also need to know where and how to look for information. Reference materials like books, pamphlets, and pictures should be easily accessible, and students should be encouraged to decide on their own what information they need. (You might check the books recommended in the REC Books lists "Reading About Real Things" and "Informational Texts.") Process skills needn't be tackled all at once. Lessons and activities that foster the growth of one or more of these skills allow students to master the skills without being overwhelmed.

Modeling inquiry skills and language involves constant "teacher talk," as ideas, questions, and findings are said aloud. This is a twofold process. Teachers can explain their own thoughts as they approach an investigation—such as "I wonder what would happen if I put these two magnets together" or "It seems that the size of that water puddle is getting smaller." Teachers can also restate and extend the thoughts of their students through discussion and the use of productive questions (see the box on page 3). Asking productive questions such as "What do you notice about…" or "How are these two things alike?" helps students focus their attention, make connections, and deepen their understandings.

"Productive Questions" an online article by Dr. Vickie Harry, provides support as you use questions with children. She offers ideas about attention-focusing questions, measuring and counting questions, comparison questions, action questions, and more!

Offering a variety of learning experiences provides opportunities for children to practice formulating and developing their own questions as well as planning how to seek answers to these questions. A simple walk outside in summer can often spur a variety of questions from children, such as "what are clouds made of?" or "Where do animals go when it rains?" Other experiences, like having a classroom pet, growing flowers in a class garden, or placing bird feeders outside the window, offer opportunities for children to practice the process of inquiry day in and day out. And practice is vital if children are to establish this inquiry "habit of mind." Once they do, they will use it in a multitude of settings and throughout life.

SPEED BUMPS AND POT HOLES ALONG THE INQUIRY ROAD

Drivers on any road must maneuver past bumps in the road to continue their journey. In the same way, children and teachers have challenges as they progress from curiosity to inquiry. However, the bumps along the road to inquiry can make the trip even more worthwhile.

CHALLENGES FOR CHILDREN

CARRYING OUT THE INQUIRY PROCESS

Because children often look to adults for answers and solutions, it is difficult for some children to have the independence and confidence in themselves to find answers. Teachers can help these children by asking probing questions such as "What do you think will happen?" or "Where could we look for information about this?" instead of supplying all the answers for children's questions and solving all their problems.

USING EVIDENCE TO SUPPORT EXPLANATIONS

Children understand the concept of cause and effect. However, if an observed effect calls into question a strongly held belief of how something operates, children will tend to fall back on the belief rather than the science. For example, some children will cling to the idea that a tall glass will hold more liquid than a shorter one even if their observations do not support this idea. Teachers can help children clarify such misconceptions by repeatedly redirecting them to focus on the evidence and emphasizing that conclusions must be based on that evidence.

COMMUNICATING IDEAS

Many times children cannot communicate their curiosity, nor the depth of the understanding that develops after engaging in inquiry. Teachers can help children communicate by offering a multitude of ways for them to question, explain, and inquire. When children seem curious about the world around them, depending on their needs, teachers can model and help children try verbal reflection, concept mapping, brainstorming, making charts, photographing, drawing, dictating thoughts, or free writing.

CHALLENGES FOR TEACHERS

TIME

Moving from curiosity to inquiry takes time. There is no way around it; don't expect to see simple curiosity one day and full-fledged inquiry projects the next. Ease into doing inquiry slowly by working on individual process skills first.

Plan one experience during which children use magnifying glasses to make observations of leaves, bugs, and anything else that looks interesting in the schoolyard. The idea is to spark questions that the children will insist on investigating. "How many legs do ants have?" "Do ants and beetles have the same number of legs?" "Do all bugs have the same number of legs?" They can discuss, organize, and refine their questions and then "write" and post them for later investigation. (If children are in prewriting stages, it might be helpful for adults to keep additional notes on the questions for later reference, in case only the children who posted the questions can "read" them.)

If questions don't immediately come during the first experience, go outside again and again armed with magnifying glasses, and use productive questioning techniques (discussed previously), or review with children other similar probing questions. Later ask children to revisit their "bug legs" questions, and begin with the children to formulate a plan of action on how to investigate those questions. Subsequent lessons could build on the investigation process, engage children in collecting evidence, and let them communicate what they found.

CLASSROOM MANAGEMENT

No doubt about it. Inquiry involves a lot of energy and activity. Children have a ton of ideas and questions they want to share. To help organize learning in the classroom, have simple systems in place that foster independence: Have the class help you create inquiry guides that list the main questions that students need to think about before starting an investigation (i.e., What is my question? What materials do I need? Where can I find information? What do I need help with?). Use pictures and other clues in the guides to help prereaders remember what to ask themselves as they seek answers on their own.

So children can find the tools they need to discover answers, be sure the materials are readily available, and clearly mark storage containers with labels and picture cues.

Post the steps of inquiry, and refer children to them often. For younger students, read the steps aloud often. Let the children restate them and clarify them for the group.

GUIDANCE

The tricky part along the journey from curiosity to inquiry is gauging how much guidance to give children in each situation. The key is to help without taking over. Children need to know that they can ask for help without surrendering their independence. Except for situations that require immediate intervention (for example, those that may be dangerous), it's usually best to wait at least a moment before taking action.

THE DEVELOPMENTAL PROGRESSION OF BASIC INQUIRY SKILLS

Children can begin learning inquiry process skills at a very early age. As they grow, they expand the variety of skills used to investigate. The following list outlines some examples of developing inquiry skills in children from infancy to elementary school age.

INFANTS INVESTIGATE BY OBSERVING

- Zoe sees the sunlight as it shines through the windows.
- She hears the wind chimes make sounds as they are touched.
- She notices that the flower is a bright color, and it tickles her nose. Its petals are soft, and they can fall off.

TODDLERS INVESTIGATE BY OBSERVING AND DOING

- Elijah opens the shade, and sunlight shines through the windows. If he closes the shade, the room is dark.
- If he hits the wind chimes hard all together, they sound different than if he hits them softly. Sometimes as he feels the wind, he hears the wind chimes make a sound.
- He can plant seeds and watch them grow. He waters them, and they get bigger and bigger.

PRESCHOOLERS INVESTIGATE BY OBSERVING, DOING, AND QUESTIONING

- Mariah stands in front of the window. "What shadows can I make?" she thinks. "Do all things make a shadow? Why isn't the shadow the same all the time?"
- She wonders, "Do all wind chimes sound alike? Why don't these two chimes sound the same? Why don't they make a sound if I hold them?"
- As she plants some seeds, she thinks, "What will these seeds grow into? Why do these seeds look different from those? What do plants eat?"

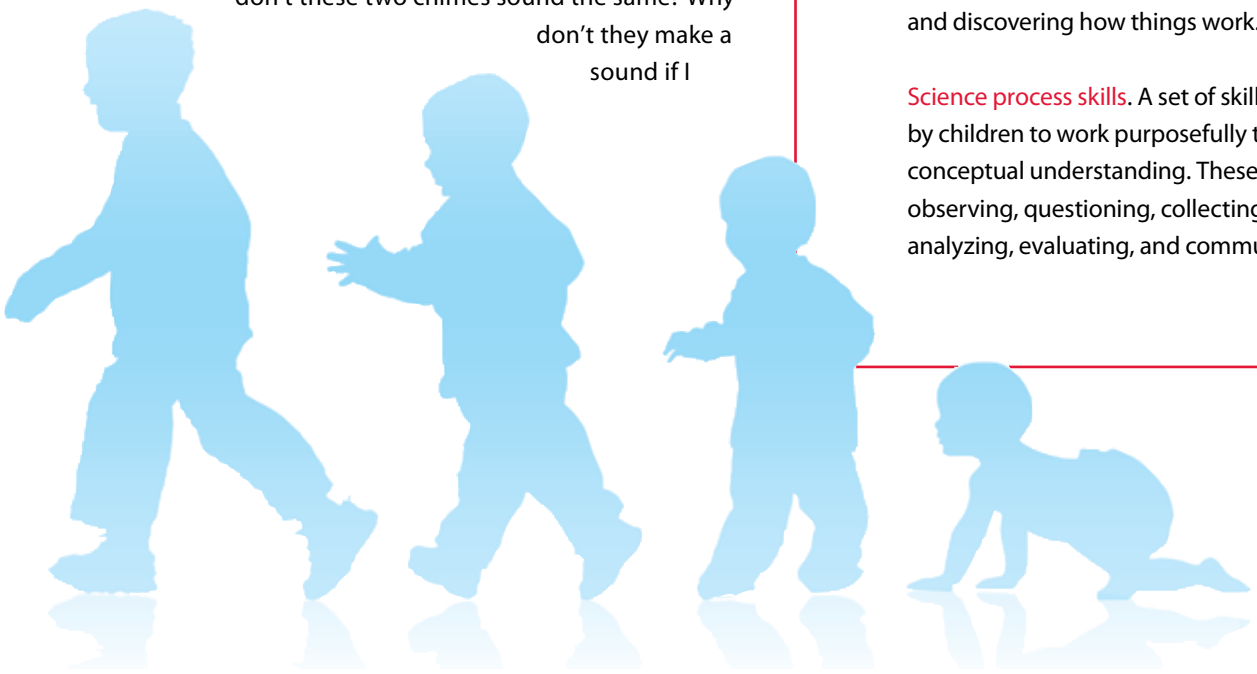
ELEMENTARY SCHOOL CHILDREN INVESTIGATE AND INTEGRATE INVESTIGATIONS

- Grant wants to find out why and how the sun rises and sets in a pattern. And "How does this affect shadows?" he wonders.
- He wants to find out why and how things are set into motion. "Can motion produce sound?" "How do wind chimes work?"
- He wants to find out why plants need certain things in order to grow. "What do plants need to grow?" "Can I eat seeds?" "Can I find seeds in apples, tomatoes, cucumbers, and other plants?" "Do all plants come from seeds?"

KEY TERMS

Inquiry. A thinking and hands-on process that engages children in solving problems and discovering how things work.

Science process skills. A set of skills needed by children to work purposefully toward conceptual understanding. These skills include observing, questioning, collecting evidence, analyzing, evaluating, and communicating.



CONCLUSION

Curiosity is a natural part of young children's lives, and when it is nurtured and encouraged in intentional ways by teachers and others, it can grow into something even more meaningful. So the idea is to start children on a journey from curiosity to inquiry by fueling their curiosity—by asking purposeful questions, supplying hands-on tools for exploration and discovery, dedicating blocks of time for exploration, and creating an environment that encourages observation, demonstration, and explanation—and then stepping aside a bit so inquiry can freely develop.

INQUIRY IN THE CLASSROOM

The following websites provide additional information and examples of best practice in inquiry-based early childhood science settings.

Setting the Stage for Inquiry by Doris Ash
Doing inquiry in the classroom takes practice and preparation. Follow the experiences of a new second grade teacher as she explores and defines techniques for preparing her children and their environment for the investigation process.
http://www.nsf.gov/pubs/2000/nsf99148/ch_8.htm

Scientific Inquiry: A Lesson from Science NetLinks
This lesson exemplifies an exploration of the outdoor environment using careful sensory observation followed by recording and communicating the observations.
http://www.sciencenetlinks.com/lessons.cfm?DocID=116

Preschool Scientists: A Tool Kit for Early Childhood Science Education
A teacher and her young children undertake a scientific exploration as part of a unique curriculum development project known as the Tool Kit for Early Childhood Science Education. Funded by the National Science Foundation, the Tool Kit project brings preschool teachers together with educators at EDC to develop a full set of quality science materials for preschool classrooms.
http://main.edc.org/newsroom/features/toolkit_earlyscience.asp

How Does My Garden Grow? Writing in Science Field Journals
This lesson plan invites children to observe and explore their environment in much the same way as scientists have done throughout the ages. The children work together to plant a garden and study its growth using the inquiry process of questioning and exploring. As they research and study, children record their observations in a field journal, to be shared with others—just like Lewis and Clark!
http://www.readwritethink.org/lessons/lesson_view.asp?id=846

Science in the Preschool Classroom by Kathleen Conezio and Lucia French
Teachers can use cooking, art experiences, and more to foster scientific learning. Many adults think of science as content learned, but for young children science is an open-ended search for knowledge.
http://www.journal.naeyc.org/btj/200209/PrinterFriendly_ScienceInThePreschoolClassroom.pdf

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FOR MORE INFORMATION

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Early Learning Content Standards

Scientific Inquiry Standard

Pre-K–2 Benchmark A. Ask a testable question.

Pre-K Indicators	Kindergarten Indicators	Grade 1 Indicators	Grade 2 Indicators
· *Ask questions about objects, organisms and events in their environment during shared stories, conversations and play .*	· *Ask "what if" questions.*	· *Ask "what happens when" questions.*	· *Ask "how can I/we" questions.*
· *Show interest in investigating unfamiliar objects, organisms and phenomena during shared stories, conversations and play.*	· *Explore and pursue student-generated "what if" questions.*	· *Explore and pursue student-generated "what happens when" questions.*	· *Ask "how do you know" questions (not "why" questions) in appropriate situations and attempt to give reasonable answers when others ask questions.*
· *Predict what will happen next based on previous experiences.*			· *Explore and pursue student-generated "how" questions.*
· *Investigate natural laws acting upon objects, events, and organisms.*			

Pre-K–2 Benchmark B. Design and conduct a simple investigation to explore a question.

· *Use one or more of the senses to observe and learn about objects, organisms and phenomena for a purpose.*	· *Use appropriate safety procedures when completing scientific investigations.*	· *Use appropriate safety procedures when completing scientific investigations.*	· *Use appropriate safety procedures when completing scientific investigations.*
· *Explore objects, organisms and events using simple equipment.*	· *Use the five senses to make observations about the natural world.*	· *Use appropriate tools and simple equipment/ instruments to safely gather scientific data.*	· *Use appropriate tools and simple equipment/ instruments to safely gather scientific data.*
	· *Use appropriate tools and simple equipment/instruments to safely gather scientific data.*		· *Measure properties of objects using tools such as rulers, balances and thermometers.*
	· *Make new observations when people give different descriptions for the same thing.*		

Pre-K–2 Benchmark C. Gather and communicate information from careful observations and simple investigation through a variety of methods.

· *Begin to make comparisons between objects or organisms based on their characteristics.*	· *Draw pictures that correctly portray features of the item being described.*	· *Work in a small group to complete an investigation and then share findings with others.*	· *Use evidence to develop explanations of scientific investigations.*
· *Record or represent and communicate observations and findings through a variety of methods with assistance.*	· *Recognize that numbers can be used to count a collection of things.*	· *Create individual conclusions about group findings.*	· *Recognize that explanations are generated in response to observations, events and phenomena.*
	· *Measure the lengths of objects using non-standard methods of measurement.*	· *Make estimates to compare familiar lengths, weights and time intervals.*	· *Use whole numbers to order, count, identify, measure and describe things and experiences.*
	· *Make pictographs and use them to describe observations and draw conclusions.*	· *Use oral, written and pictorial representation to communicate work.*	· *Share explanations with others to provide opportunities to ask questions, examine evidence and suggest alternative explanations.*
		· *Describe things as accurately as possible and compare with the observations of others.*	

Scientific Ways of Knowing Standard

Pre-K Indicators	Kindergarten Indicators	Grade 1 Indicators	Grade 2 Indicators
Pre-K–2 Benchmark A. Recognize that there are different ways to carry out scientific investigations. Realize that investigations can be repeated under the same conditions with similar results and may have different explanations.			
· *Offer ideas and explanations of objects, organisms and phenomena, which may be correct or incorrect.*	· *Recognize that scientific investigations involve asking open-ended questions. (How? What if?)* · *Recognize that people are more likely to accept your ideas if you can give good reasons for them.*	· *Discover that when a science investigation is done the same way multiple times, one can expect to get very similar results each time it is performed.* · *Demonstrate good explanations based on evidence from investigations and observations.*	· *Describe that scientific investigations generally work the same way under the same conditions.*
Pre-K–2 Benchmark B. Recognize the importance of respect for all living things.			
· *Recognize the difference between helpful and harmful actions toward living things.*	· *Interact with living things and the environment in ways that promote respect.*	· *No indicators present for this benchmark.*	· *Describe ways in which using the solution to a problem might affect other people and the environment.*
Pre-K–2 Benchmark C. Recognize that diverse groups of people contribute to our understanding of the natural world.			
· *Participate in simple, spontaneous scientific explorations with others.*	· *Demonstrate ways science is practiced by people everyday.*	· *Explain that everybody can do science, invent things and have scientific ideas no matter where they live.*	· *Explain why scientists review and ask questions about the results of other scientists' work.* · *Demonstrate that in science it is helpful to work with a team and share findings with others.*