# CREATIVE INVESTIGATIONS IN EARLY SCIENCE

Angela Eckhoff, PhD

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# Dedication

A special thank you to the early childhood science methods students I've worked alongside during my career. The classes we've shared exploring how to encourage children to experiment, question, get messy, and play provided me with the inspiration to make this book a reality. Thank you!

# Introduction

### Inquiry-Based Learning in Early Science

Tommy and three of his classmates are sitting together in the art area working on paintings of imagined, mythical creatures known as zoomorphic animals. Zoomorphic creatures are fantastic creations consisting of various parts of real animals put together in novel ways. This class of five- and six-year-olds has been studying the characteristics and habitats of animals for several weeks as part of the science curriculum. Tommy's teacher, Mr. Brown, had recently shared a story that features zoomorphic animals, If I Had a Gryphon by Vikki VanSickle, and many of the children expressed an interest in developing their own mythical creatures. To support this exploration, Mr. Brown stocked the classroom's science center with pictures of various animals for the children to use to explore, as well as with paints, paper, colored pencils, and a variety of markers to use in the drawing and painting phases of the project. He encouraged the students to begin by sketching draft drawings and working to modify those drawings over the course of several days. Once they were satisfied with their sketches, the children were then encouraged to use the arts media to add color and definition to the images.

The subject of Tommy's zoomorphic work is a combination of several of his favorite real-life animals and features the head of an elephant, the wings of an eagle, and the sharp spines of an iguana. Tommy's zoomorphic creature is a fantastic combination of animal characteristics that give his creature "super powers to be the strongest and fastest"—to be as strong as an elephant, to fly like an eagle, and to have the natural defenses of an iguana. As Mr. Brown comes over to talk about the boys' work, Tommy excitedly draws Mr. Brown's attention to his distinctive creature by pointing out its component parts. Mr. Brown and Tommy discuss the parts of the drawing that are associated with each animal that was used as inspiration. "Okay, Tommy," says Mr. Brown, "I have a challenge for you. If your creature has an elephant head but the body of an eagle, what does it eat?" Tommy replies excitedly that his elephant head likes to eat peanuts, not fish or squirrels like eagles do. Mr. Brown laughs and asks Tommy, "Where will this creature sleep? Will it have a nest like an eagle?" Tommy quickly answers yes and says, "He is little like an eagle so he needs to sleep up high in a nest away from big animals."



Tommy's zoomorphic creature experience provided him with opportunities to bring together his understanding of the needs and characteristics of animals as well as his creative-thinking and visual-art skills. Mr. Brown has created a learning environment that encourages and supports connections between science content and the children's desire to engage in creative experiences. The exploration of zoomorphic creatures provides unique opportunities for each child to develop his own interpretation and encourages the children to reflect and draw upon their knowledge of the physical characteristics of animals.

Mr. Brown enhanced this experience for his students by encouraging engagement with one another through the sketching and research

experiences with the animal photographs. He also extended the children's individual work by asking prompting questions.

## Young Children Are Scientists

All children are scientists; during the early childhood years, children naturally engage in the scientific processes of observation, manipulation, experimentation, and exploration. The natural curiosity of young students provides early childhood educators with an entry point from which to build classroom science experiences. Inquiry-based early childhood science education capitalizes on the interests young children demonstrate as they explore the world around them. Through creative, hands- and minds-on experiences, early childhood educators can encourage children to construct understanding of earth, life, and physical sciences in ways that are personally meaningful. The science experiences described in this book are based on the 5E inquiry model of instruction (engage, explore, explain, extend/elaborate, and evaluate) as well as the content recommendations from the *Next Generation Science Standards* (NGSS).

This book is designed to provide early childhood educators with pedagogical practices, science content knowledge, and lesson ideas that scaffold young children's experiences with earth, life, and physical science, while also building inquiry and creative-thinking skills. This book will broaden your understanding of the relationships among science content, the role of the learning environment, and supportive pedagogical practices in early childhood classrooms. When science experiences build on student interests and understanding and connect to other areas of content learning—literacy, technology, engineering, the arts, mathematics, and social studies—young children are able to experience meaningful, relevant connections among different content areas. This book stresses the importance of encouraging *minds-on* learning experiences in the early childhood classroom through guided and independent investigations, where every child is actively involved in meaningful ways. Early childhood educators have important roles in science-focused experiences and will act as both guide and facilitator throughout the planning, implementation, and assessment of the creative, inquiry-based experiences presented

throughout this book. For young children, science experiences involve using tools and a variety of materials, being creative and inventive, developing questions based on observations, exploring problems, and sharing their understanding with others.

*Creative Investigations in Early Science* will support your development of creative early science experiences in the classroom by helping you:

- understand the links among science content, inquiry-based learning, and project-based learning;
- plan cooperative science lessons that will engage all children in your classroom as individuals or when working in small or whole groups;
- implement classroom experiences that support children's engagement with science content on a daily basis;
- recognize children's understanding, beliefs, and misconceptions of science concepts and utilize that information to support the growth of conceptual knowledge; and
- document children's knowledge development with authentic work samples and classroom artifacts.

## Playful Learning

Play is an essential element in explorations of science in early childhood. Through play, young children learn about themselves, their environment, other people, and the world around them. Playful learning encourages children to explore and experiment in situations where they feel comfortable taking risks and delving into the unknown. Children's play in the early childhood classroom can take on many different forms and functions. When children explore, experiment, and cooperate through play, they learn about how the world works. Children need teachers who are supportive of their play and who work to carefully identify play situations where teacher guidance or involvement are welcome and needed. Young children use their knowledge and understanding by bringing these ideas into their play to further experiment and clarify their understanding. This process is child driven; the role of the adult is one of supporter, guide, and facilitator. The adult meets each child at his own stage of understanding with intentional pedagogical practices that promote questioning and exploration. Teachers can create early childhood classrooms that honor the ways in which children learn and explore by ensuring that young children have ample opportunities for playful learning and exploration. In the role of supporter, guide, and facilitator, the teacher carefully observes children's play and helps encourage children's thinking through questioning and providing additional, supportive materials and opportunities for guided learning.

### Guided Inquiry in Early Science Experiences

Inquiry-based learning can play a central role in the development of meaningful learning opportunities as children explore emerging skills in early science. Contrary to traditional notions of the teacher's role as a teller of information, teachers in inquiry classrooms perform the roles of guide, facilitator, and provocateur by asking questions and designing meaningful lessons built on student interests. A teacher's ability to listen to her students is a foundational component of the use of guided inquiry in science explorations. By carefully listening to students and reflecting on their ideas and interests, you will be able to plan and implement engaging and meaningful science explorations with your students that encourage individual expression.

Inquiry-based science experiences in early childhood classrooms are based on the 5E instructional model, where students are first engaged in the topic and then explore using materials and media, which is then followed by opportunities for explanation and elaboration. In the 5E model, both teachers and students work to evaluate ideas and understanding throughout the entire experience (Bybee et al., 2006). Inquiry-based science learning requires planning and intensive engagement on the part of the teacher as well as attentiveness and active engagement on the part of the children. It is recommended that early science experiences incorporate opportunities for exploring both content and inquiry skills. Inquiry-based learning requires these process skills: observation, exploration, questioning, making predictions, using simple tools and technologies, and conducting simple science investigations. In the introduction to each chapter of the book, you will find suggested ideas and practices for each phase of the 5E model based on the content covered in that chapter.



The 5E Model

#### Engage

Students come to learning situations with prior knowledge, incomplete understanding, and even misconceptions. The *engagement* phase of the model provides opportunities for teachers to find out what students already know or believe about the concept under exploration. This phase also gives the children an opportunity to think about and discuss their thoughts about the concept. The engagement phase is important because it offers an opportunity to capture student interest and inspires young children to want to find out more.

#### Explore

The *exploration* phase of the inquiry cycle involves the hands-on, mindson engagement of students. During the exploration phase students will be actively working as individuals or as part of a group investigating materials, ideas, and questions. Time and space are important elements to exploration, so in this phase you will need to provide children with ample time and physical space to conduct their investigations. The exploration phase can take place over several days or even weeks, depending on the concept under investigation and the children's interest.

#### Explain

The *explanation* phase of the inquiry model provides opportunities for students to connect their prior understanding with their current experiences. Through both verbal (discussion) and physical explanations (drawings, journals, models), the explanation phase helps students develop their conceptual understanding of the science content. Because of the emphasis on sharing understanding, this phase also provides opportunities for you to introduce science language and terms to help support students' explanations. Prompting questions you can pose during this phase may include the following: What did you notice? How can you show us what you know or experienced? Can you tell us more about why you think that happened?

#### Elaborate

The *elaboration* phase of the inquiry model provides opportunities for children to apply or extend previously introduced concepts and experiences to new situations. In early childhood classrooms, opportunities for elaboration can begin through follow-up experiences in the science center or during paired or small-group experiences. In the elaboration phase, it is important for students to have opportunities to discuss and compare their ideas with others.

#### Evaluate

In early childhood science experiences, informal observations and interactions with students throughout all phases of the inquiry model are the most appropriate ways to gather information on student understanding. The *evaluation* phase should always be directly connected to students' in-process work rather than the end product of an experience. You can engage your students in the evaluation phase by encouraging them to share their experiences and understanding with others and to listen and respond to the ideas of their peers.



*Misconceptions* are ideas that a person may have that are not aligned with accepted scientific views. We all have science misconceptions; many are formed about concepts that are frequently misunderstood. A common misconception you have probably heard more than once is that humans only use 10 percent of their brains. Cognitive scientists have worked for years to change this misconception by stating that there is no scientific evidence to suggest that we use only 10 percent of our brains. In fact, brain imagining demonstrates that when we move, speak, or think about a particular object, brain activity is widely noted in many regions. However, once many of us hear this myth, it stays with us and we may repeat it to others. Like adults, young children frequently have misconceptions. A few common misconceptions they may hold are the following:

- Rain comes from holes in clouds.
- It rains because we need or want it.
- Leaves pick the color they want to change to in the fall.
- Humans are not animals. The moon can only be seen during the night.
- There are four separate moons.

If we spend some time thinking about these misconceptions, we can begin to understand how children develop these ideas. When children look at the sky on a rainy day, they may see clouds that appear to have holes,

# **1** Physical Science: Understanding Matter and Physical Properties

Young children explore their world using their five senses to take in information about the physical properties of objects. These explorations serve as a foundation to understanding objects and the behaviors of those objects under various conditions. A young child licking a frozen treat outside on a warm summer day quickly learns that it can melt before she is finished! These direct, informal experiences allow children to make inferences about the reasonable and sometimes unreasonable explanations of consequences.

Matter is anything that has mass and takes up space. Mass is the amount of matter in an object and differs from weight, which is a measurement of the gravitational pull on an object. Young children can readily explore the physical properties of matter, including size, shape, color, texture, hardness, melting point, magnetism, and whether an object sinks or floats. Explorations with the physical properties of matter provide creative opportunities for inquiry-based learning through making observations, developing predictions, and conducting simple experiments.

#### The Cycle of Inquiry: Matter and Physical Properties

#### Engage

Questions to Engage: Matter and Physical Properties

Ask these types of questions to engage young learners' interests:



- Which of these objects do you think is heavier? What makes you think that?
- What do you think will happen if we put this ice cube in the sun and put this one in the shade? Why will it melt faster/slower?
- What do you think this object will feel like in your hand?
- Can you describe this object with one word?

#### Explore

#### Engaged Exploration: Matter and Physical Properties

To assist children as they work to explore the world around them, provide a space in the classroom that allows them to do the following:

- Sort, compare, and classify objects by their physical properties (color, shape, texture, size, weight, and solid or liquid state
- Explore water and objects (sink or float)
- Touch objects of varying textures and materials

#### Explain

#### **Explanation Opportunities: Matter and Physical Properties**

Use the following suggestions to help children understand and explore class lessons on a deeper level:

- Display properties charts in the classroom
- Display photographs of experiments with student quotes
- Plan whole-group debriefings that discuss observed changes in matter
- Encourage students to draw, write, and comment in their science journals
- Develop whole-class exploration charts with objects that sink or float, objects that are magnetic or nonmagnetic, and objects that are hard or soft

#### Elaborate

#### Science Center Elaborations: Matter and Physical Properties

Engage your students with the following ideas to continue their learning:

- Plan water play indoors or outdoors with a variety of natural and man-made objects to test whether they sink or float
- Test magnets and a variety of materials to learn about magnetism
- Classify a variety of materials to explore the size, shape, color, texture, or hardness properties

#### **Evaluate**

#### Documenting Informal Evaluation: Matter and Physical Properties

Assist your students as they evaluate their learning from the explorations by using the suggested ideas:

- Plan whole-class review sessions
- Have a science night for families and friends
- Display documentation panels of major projects
- Display student portfolios
- Involve students in planning next steps based on their wonderings



#### **Properties of Matter**

- Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature.
- Matter can be described and classified by its observable properties.
- Different properties are suited to different purposes.
- A great variety of objects can be built from a small set of pieces.
- Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not.

Source: NGSS Lead States. 2013. Next Generation Science Standards: For States, by States. Washington, DC: National Academies Press.

### **Lesson Ideas**

### **Object Grab Bag**

#### Topic:

Describe and sort objects by their physical properties: color, shape, texture, size, and weight.

#### **Objective:**

Children will explore the properties of objects and describe a selected object to their peers.

#### Materials:

Small paper sack (or any opaque bag)

Small items from the classroom that have properties the children can describe (colorful building blocks or math counters; crayons; craft sticks; glass or plastic cabochons of various sizes, colors, and shapes; stones; and tiles of various sizes and shapes). Items



should be small enough to be hidden inside a child's clasped hands.

#### **Overview:**

This game can take place during whole-group time or in small groups.

#### Activity Steps:

1. Prior to starting the game, gather enough items for each child to have at least one turn selecting an item. Talk with the children about how they are going to take turns selecting a mystery object from the bag that they will describe to the other students without saying what the object is. The class will then take turns guessing the item based on the students' description. If this is their first time playing the game, be sure to play a practice round or two so that the students understand how to describe objects and when to make guesses.

- 2. Invite a child to begin the game by selecting the first object without looking in the bag. Encourage the child selecting the object to give one descriptive clue at a time. Have the child face you with her back to the class so that she can pull the object out of the bag and peek at it before covering it with her hands. Once she is ready, she can turn to face the class for the guessing to begin.
- 3. You may want to prompt the child to describe her item until the class gets used to providing descriptive clues. Prompting questions can include the following: Can you describe the color of your object? Can you describe the shape of your object? Is your object heavy or light? How does your object feel when you touch it? Where do we play with that object in the classroom?
- **4.** After the children guess the object, invite the next child up to select an object until each child has had a turn.

#### **Documentation:**

Take anecdotal notes about the children's abilities to describe the properties of selected objects.

#### **Extension Lesson:**

This lesson can be extended by using specific groups of objects, such as objects from nature, to extend science explorations taking place within the classroom.

### **Dancing Liquids**

#### Topic:

The properties of objects can be described.

#### **Objective:**

Children will explore how various liquids react when they are placed on a variety of surfaces. **Creativity Skills:** 

Exploration

Communication/ collaboration

## RESEARCH, question, ANALYZE, and discover... START EXPERIMENTING!

### Young children are born scientists with an innate desire to analyze and investigate the

world around them. Expand their learning and encourage their inquisitive nature as you explore the physical, life, and earth sciences together! *Creative Investigations in Early Science* will help you to guide preschoolers' learning as they study seasonal transitions, explore basic chemical changes, and learn about matter and physical properties. Children will develop an early love for the sciences as you help them research, question, experiment, analyze, and discover through open-ended explorations. You'll feed their curiosity while enhancing their STEM skills!

Teachers and parents alike will learn practical and approachable ways to intentionally foster their young scientists' hands-on, minds-on explorations in the following areas:

- Matter and physical properties
- Physical and chemical changes
- Conservation and sustainability
- Earth and space systems

Guide your young STEM learners as they explore both on their own and collaboratively to grow their knowledge about the world around them.



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