The Power of Investigating: Guiding Authentic Assessments

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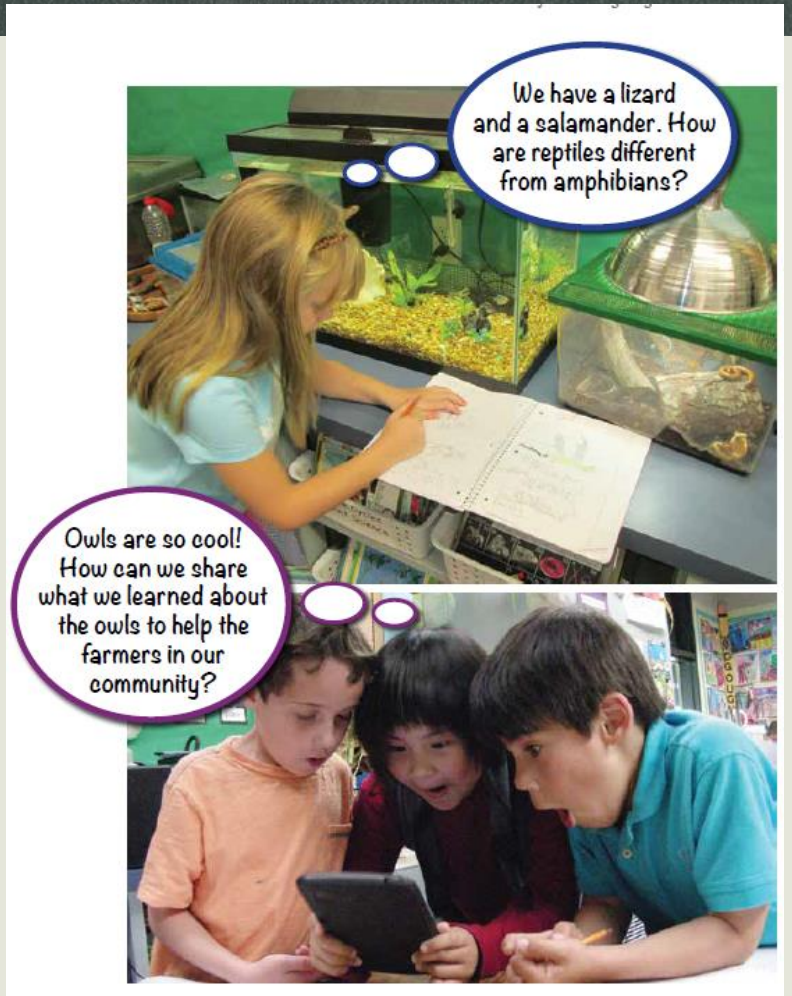
Why Investigate?

“We keep moving forward, opening new doors, and doing new things, because we’re curious and curiosity keeps leading us down new paths.”

—Walt Disney

How Do Purposeful Investigations Engage Students in Standards Based Learning?



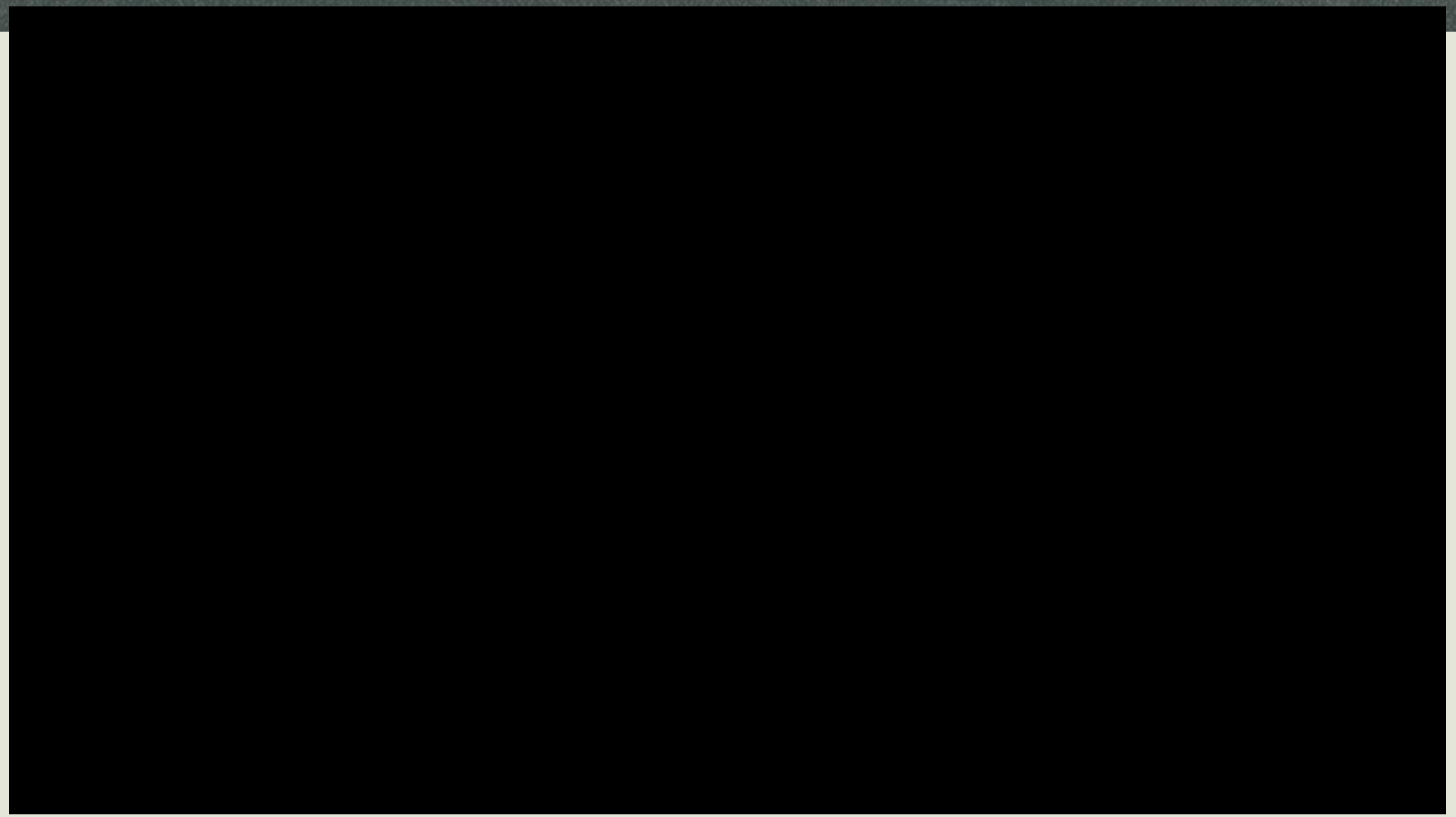
A Closer Look

A student uses a microscope to see the features of the worm up close and investigate how worms and amphibians are similar and how they are different. She read that amphibians breathe through their skin. She can see the rings of the worm and notices how the worm's skin looks moist. The student will connect her firsthand observations to literacy as she reads nonfiction text about worms and asks further questions.

Drawing Details

A student investigates the real worm and adds details to her drawing. Hands-on investigations offer English-language learners the opportunity to describe, explain, and develop vocabulary in context. Further writing and close-reading strategies enhance concept development and literacy skills.

How Do Three-Dimensional Learning Experiences Build Literacy Skills?



What Can This Look Like in Primary Grades?

Figure 1.3. Students Analyze a Chart Showing Characteristics of Birds of Prey to Gather Evidence for a Writing Task

Grade	*NGSS* DCI (NGSS Lead States 2013)	*CCSS* (NGAC and CCSSO 2010)
K	**LS1.C Organization for Matter and Energy Flow in Organisms** All animals need food in order to live and grow. They obtain their food from plants or from other animals. Plants need water and light to live and grow.	**ELA-LITERACY. W.K.7** Participate in shared research and writing projects (e.g., explore a number of books by a favorite author and express opinions about them). **ELA-LITERACY.SL.K.1** Participate in collaborative conversations with diverse partners about *kindergarten topics and texts* with peers and adults in small and larger groups. **MATH.CONTENT.K.MD.B.3** Classify objects into given categories; count the number of objects in each category and sort the categories by count.
1	**LS1.A Structure and Function** All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water, and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow.	**ELA-LITERACY.RI.1.1** Ask and answer questions about key details in a text. **ELA-LITERACY.W.1.7** Participate in shared research and writing projects (e.g., explore a number of "how-to" books on a given topic and use them to write a sequence of instructions). **ELA-LITERACY.SL.1.3** Ask and answer questions about what a speaker says in order to gather additional information or clarify something that is not understood. **MATH.CONTENT.1.MD.C.4** Organize, represent, and interpret data with up to three categories; ask and answer questions about the total number of data points, how many in each category, and how many more or less are in one category than in another.
2	**LS4.D Biodiversity and Humans** There are many different kinds of living things in any area, and they exist in different places on land and in water.	**ELA-LITERACY.W.2.7** Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations). **ELA-LITERACY.W.2.8** Recall information from experiences or gather information from provided sources to answer a question. **MATH.CONTENT. 2.MD.D.10** Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph.

Key: LS = life science, MD = measurement and data, RI = reading informational text, SL = speaking and listening, W = writing

What Can This Look Like in Intermediate Grades and Beyond?

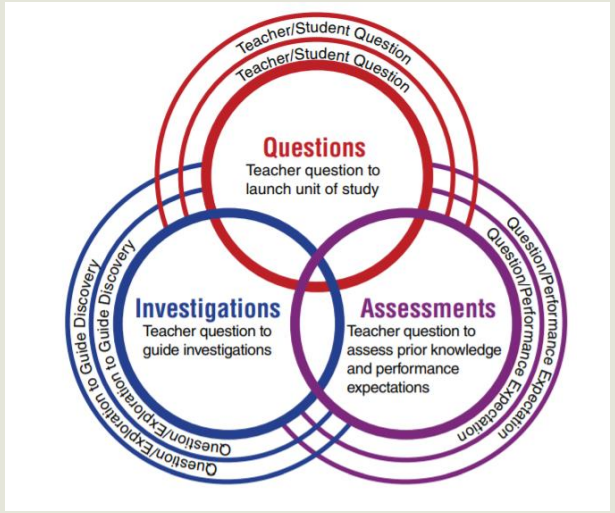
Figure 1.4. Using a Digital Microscope, Fifth-Grade Students Take an Up-Close Look at the Gills of a Shark

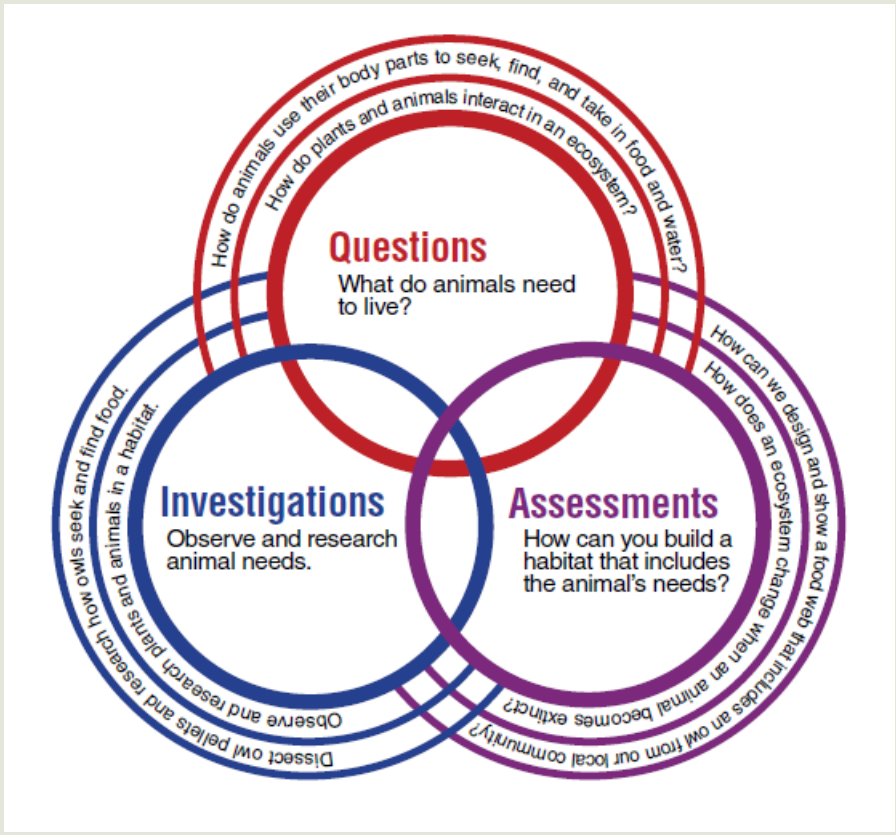
Table 1.2. Possible Primary (Grades 3–5) Standards Pairings for Science, English Language Arts/Literacy (ELA-LITERACY), and Mathematics (MATH)

Grade	*NGSS* DCI (NGSS Lead States 2013)	*CCSS* (NGAC and CCSSO 2010)
3	**LS4.D Biodiversity and Humans** Populations live in a variety of habitats, and change in those habitats affects the organisms living there.	**ELA-LITERACY.W.3.2** Write informative/explanatory texts to examine a topic and convey ideas and information clearly. **ELA-LITERACY.RI.3.1** Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. **ELA-LITERACY.SL.3.4** Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace. **MATH.CONTENT.3.MD.B.3** Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step "how many more" and "how many less" problems using information presented in scaled bar graphs. *For example, draw a bar graph in which each square in the bar graph might represent 5 pets.*
4	**LS1.A Structure and Function** Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (Assessment Boundary: Assessment is limited to macroscopic structures within plant and animal systems.)	**ELA-LITERACY.W.4.1** Write opinion pieces on topics or texts, supporting a point of view with reasons and information. **ELA-LITERACY.SL.4.1** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 4 topics and texts*, building on others' ideas and expressing their own clearly. **ELA-LITERACY.RI.4.3** Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.
5	**LS2.B Cycles of Matter and Energy Transfer in Ecosystems** Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases and water from the environment and release waste matter (gas, liquid, or solid) back into the environment.	**ELA-LITERACY.RI.5.7** Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. **ELA-LITERACY.SL.5.5** Include multimedia components (e.g., graphics and sound) and visual displays in presentations when appropriate to enhance the development of main ideas or themes.

Key: LS = life science, MD = measurement and data, RI = reading informational text, SL = speaking and listening, W = writing

Why Is Questioning Important for Linking Literacy to Learning Investigations and Authentic Performance Assessments?





Types of Investigations

Investigation Type	Investigation Purpose	Investigation Questions	Example
Launch	• Engage learners with a phenomenon or discrepant event. • Create questions and purpose for further investigations. • Make and record observations. • Collaborate and make connections.	• What do you think will happen? Why? • Why do we need to organize our information? • What characteristics does an amphibian have? • What do we know about _____?	• An orange sinks or floats. • Organizing ideas in writing • Amphibian observation • Owl video clip and discussion
Focus	• Make and record observations. • Organize information. • Collaborate and research answers to questions. • Collect and organize data.	• What do you observe? • How does it change when ____? • What happens when two animals in an ecosystem eat the same thing? • What did you find?	• Raisins sink or float. • Collaborative writing • Research food chains. • Dissect owl pellets.
Station	• Make and record observations. • Research information. • Organize information. • Plan and carry out new investigations.	• What will happen when you add a liquid with a different density? • What evidence from text can you find to support your thinking? • How are amphibians and reptiles alike and different? • What are the parts of a ___?	• Density columns • Collect information about amphibians and reptiles. • Make a chart to compare and contrast. • Create a diagram and label the animal's parts.
Spontaneous	• Create student ownership of the learning environment and explore student connections. • Encourage ongoing learning as ideas and opportunities become available.	• Where did you find ___? • How does this connect to our learning about ___?	• Artifact found on campus, at home, or on a trip • Connection to a field trip or other learning experience
Ongoing	• Observe changes over time. • What can we plan to investigate this idea further?	• How long does each stage of the life cycle take? • How does the baby bird change before it is ready to leave the nest?	• Animal (salmon) life cycle • Animal growth (live web cam)

How Do Launch Investigations and Focus Investigations Guide Learning Experiences?

Launch Investigation

Whole group

The teacher initiates the exploration of a topic with a discussion, demonstration, and/or presentation. For example, the teacher leads students to work together to organize their ideas. They discover the reason for grouping information and writing sentences in a logical order.

Focus Investigation

Small group

The teacher provides an opportunity for the students to make a deeper connection to the topic and extend the learning of the launch investigation. For example, the teacher guides students as they discuss and organize information about animals in an ecosystem to build a food web.

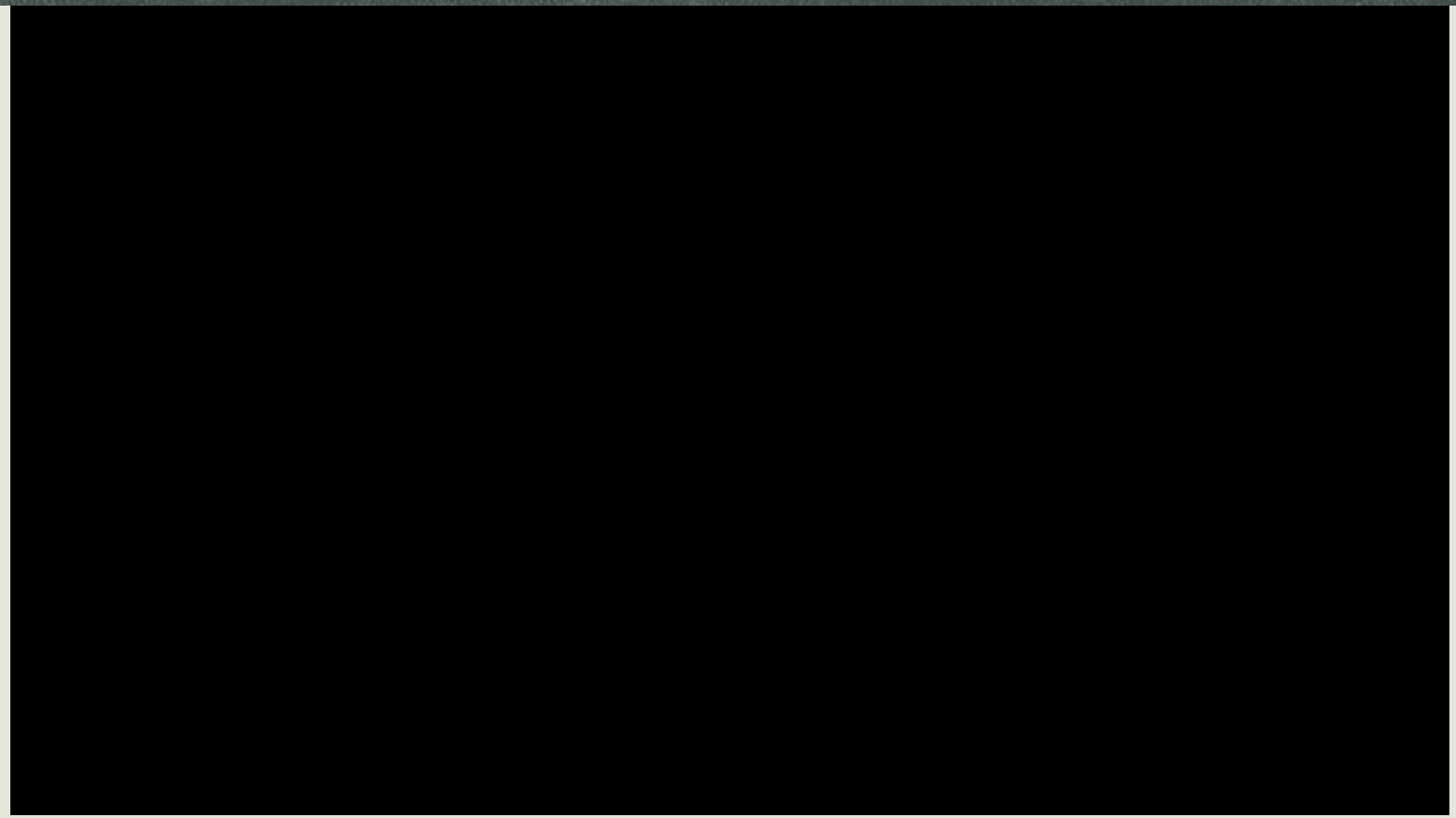
How Do Launch Investigations and Focus Investigations Guide Learning Experiences?

How Does a Station Investigation Support Learning Goals?

Station Investigation

Small group or individual
The teacher monitors the progress of students as they conduct independent research. For example, the students use close-reading strategies to organize ideas and questions from informational texts.

How Does a Station Investigation Support Learning Goals?



How Does a Spontaneous Investigation Inspire Further Investigations?

Spontaneous Investigation

Whole group, small group, or individual

Students or the teacher bring a discovery (or an interesting find) to the classroom. For example, a student might share the discovery of a salamander. The students may use print resources from the school library to investigate what the salamander needs for a short classroom visit.

How Does a Spontaneous Investigation Inspire Further Investigations?

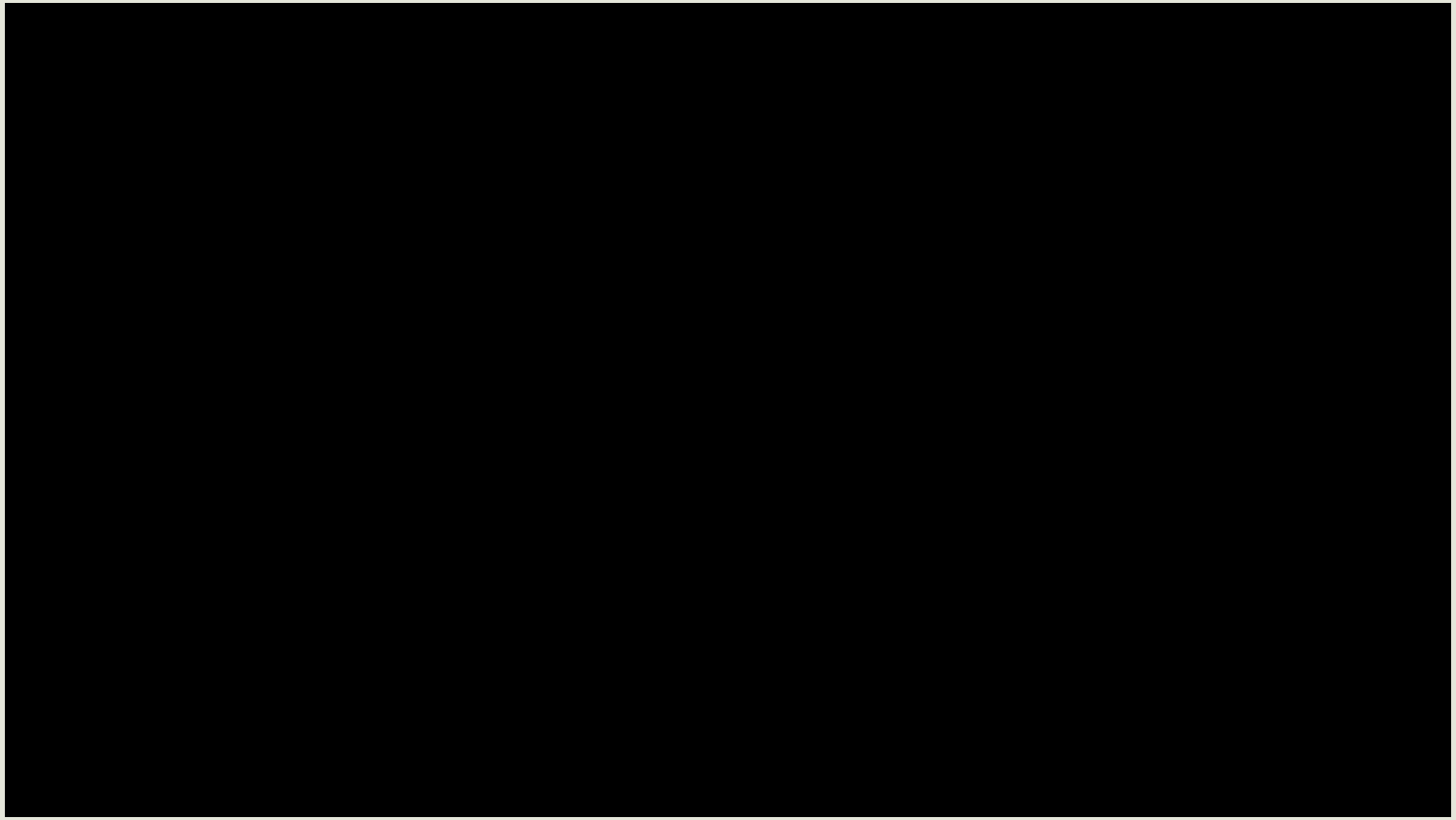
How Does an Ongoing Investigation Support Thinking and Learning?

Ongoing Investigation

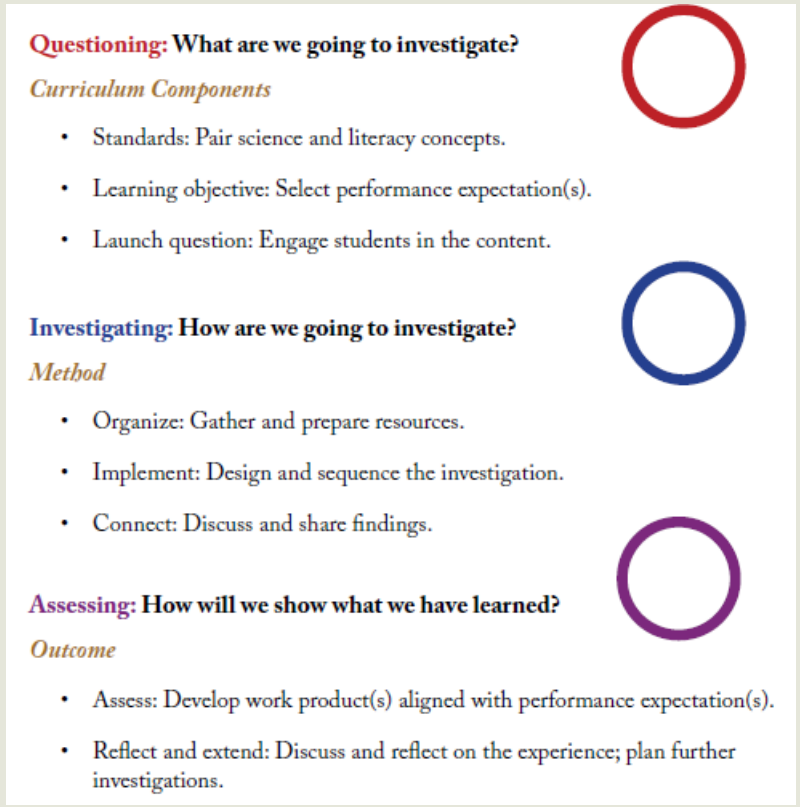
Whole group, small group, or individual

Students have an opportunity to explore a topic over a longer period of time. For example, salmon eggs are raised in a classroom. Over a period of weeks, the students make observations and record data to monitor changes in the life cycle of the salmon.

How Does an Ongoing Investigation Support Thinking and Learning?



Investigation Lesson Design Guide



- Questioning
  - Which science and literacy standards best fit the concepts for this investigation?
  - What will students do to meet the learning objective, and when and how will they do it?
  - What question will you use to engage students and launch the investigation?
- Investigating
  - What materials and resources will you need to investigate the concepts?
  - How will you encourage collaboration and fuel the investigation with questions?
  - How will you sequence the investigation (for example, launch investigation, then focus investigations, then whole-group discussion)?
  - How will your discussion help students reflect on their learning and share their findings?
- Assessing
  - How will students document and record their observations, thinking, and data?
  - How will students show what they know and demonstrate that they met the objective?
  - What investigations will you plan to answer new questions and extend thinking?

Launch Investigation Guide

Launch Investigation Guide

A launch investigation engages learners with a phenomenon, discrepant event, or discussion. Use divergent questions to engage students. For example, ask, "What do we know about ___?" This whole-group investigation helps the teacher assess students' previous knowledge and prepares students to ask probing or clarifying questions during a focus investigation or station investigation. Launch investigations get the learner's attention and lead to guided or independent investigations. Students make connections, develop questions, and support critical thinking.

What **launch question** will engage students in this whole-group investigation?

What **materials** do I need to create interest for this concept and engage students in the investigation? What safety considerations are there and how will I address them?

What questions will I use to **assess** previous knowledge and **connect** to the focus investigation?

How will I **transition** students to the focus investigation? How will I **support** further thinking?

Launch Investigation Guide Example

Question

How do we know what an animal eats?

Materials

- Printed or digital photographs of animals
- Informational books about animals
- Video clips about animals from the website of Wildscreen Arkive or National Geographic Society

Assess Prior Knowledge

- What do students know about animals and what they eat?
- Do students use the terms *herbivore*, *carnivore*, or *omnivore*?
- Do students talk about animals as predators and prey?

Connect to the Focus Investigation

What happens if two animals in a habitat eat the same thing (for example, if an owl and a snake both eat rats)?

Transition to the Focus Investigation

Explain to students that they will be working in small groups to build a food web of an animal. Students will look through the printed photographs and discuss how the animals interact. Students will organize the pictures and use yarn to illustrate what the animals eat. Have supplies ready and dismiss students to work in groups.

Support Further Thinking

Other questions to support further thinking include "What are other parts of a food chain or food web besides animals?" "How will you represent these parts in your food web?" and "What would happen if an animal moved to a different ecosystem?"

Focus Investigation Guide

Focus Investigation Guide

A focus investigation engages learners in small groups to make and record observations, collaborate and organize data, and/or build and test models. Use divergent questions to engage students, asking, for example, "What do you observe?" Use clarifying or probing questions to support thinking; for example, "How does it change?" or "Why do you think that?" A focus investigation is guided by the teacher as he or she moves into and out of small groups while students collaborate during the investigation. This type of investigation works well after a launch investigation. A whole-group discussion after the focus investigation helps students synthesize learning.

What **questions** will focus students on the investigation?

How will I **prepare** and **manage** materials for small groups? What safety considerations are there and how will I address them?

How and where will students **record** observations, data, and questions? What **steps** will students follow to conduct the investigation?

How will I **transition** students to discuss the investigation and close the lesson? How will I **support** further thinking?

Focus Investigation Guide Example

Question

How do plants and animals interact?

Preparing Materials

Print photographs from the website of Wildscreen Arkive of animals in a food chain; cut lengths of yarn; and gather scissors, markers, and construction paper.

Managing Materials

Organize materials for each group of students. Have one student from each group come up to get the group's materials.

Steps

1. Students discuss the photographs in a small group.
2. Students decide how to organize the photographs according to what animals eat.
3. Students label each animal and make additional animals, plants, and the Sun to complete the food chain.
4. Students connect the pictures with yarn.

Transition to Group Discussion

Get students' attention and ask them to put away materials and be ready to discuss their food web with the class. Choose a group to share their food web. Ask probing questions to help students share their work; for example, ask, "Why did you put the owl and the snake above the rat?" or "What would happen if one of the animals in the food chain became extinct?"

Support Further Thinking

How can you create a food web using technology for different animals (for example, using Kidspiration® software to create a food chain for a salamander)?

Station Investigation Guide

Station Investigation Guide

A station investigation engages learners in small groups to make and record observations; research, read, and write; collaborate and organize data; and/or build and test models. A station investigation is mostly independent student work in a small group setting, but supported by the teacher as needed. This type of investigation works well after a launch investigation or after a focus investigation, when students want to investigate a concept further. Books, vocabulary, technology resources, and question prompts can be organized in the station area to support students.

What **question** prompts will focus students on the investigation?

What **materials** and **resources** will help students work independently in a station investigation? What safety considerations are there and how will I address them?

How and where will students **record** observations, data, and questions? How will students use the **resources** for the investigation?

What **formative assessment** will inform and support further lessons?

Station Investigation Guide Example

Question

How are salamanders and frogs alike and how are they different?

Preparing Materials

Organize the station space: Include relevant books, pencils, paper, journals, colored pencils, and other needed resources. If live amphibians are in the classroom, organize the observation tools (for example, a microscope and/or a hand lens).

Organize Resources

Gather and display books about salamanders and frogs. Locate and mark internet resources relevant to amphibians on computers or tablets.

Recording Observations and Evidence From Text

Students may work independently or collaboratively in a small group setting.

Students will make observations, locate evidence from text, and record findings in science journals or notebooks.

Using Materials and Resources

Students will use a hand lens and/or the digital microscope to observe amphibians.

Students will use books and internet resources to locate evidence from text to support observations.

Formative Assessment

Teachers assess students' work through questioning strategies as they interact with the station group; for example, ask, "How is the skin of a salamander similar to the skin of a frog?"

Teachers assess student science journals according to information recorded and evidence from text to support observations (for example, "Frogs live in wet places to keep their skin moist. Salamanders have tails and frogs do not.").

Spontaneous Investigation Guide and Ongoing Investigation Guide

Spontaneous Investigation Guide

A spontaneous investigation cannot necessarily be planned; however, you can think about how you will respond to a child's discovery when shared with the class. The spontaneous investigation provides an opportunity for a child to take ownership in his or her learning and inspire new questions to investigate. Sometimes a child's discovery relates to current learning experiences happening in the classroom, and sometimes it provides a teachable moment.

What is the **discovery**?

What **materials** do I need to gather to support and possibly extend the discovery (for example, books, observation tools, and technology resources)? What safety considerations are there and how will I address them?

What **questions** will I use **to guide** the observation and possible further investigations?

How can I **connect** this discovery to literacy standards or other content standards (for example, close reading, journal writing, and station investigations)?

Ongoing Investigation Guide

An ongoing investigation engages learners over a period of time that could last days or longer. It provides opportunities for data collection and/or documentation of changes over time (for example, animal life cycles, crystal formation, and evaporation).

What **concepts** within this unit of study offer opportunities to observe changes over time?

What **materials and resources** will I have available to support the ongoing investigation, such as books, technology resources, observation tools, journals, and notebooks? What safety considerations are there and how will I address them?

What **questions** will I use to continue the development of concepts over time?

How can I **connect** this discovery to literacy standards or other content standards (for example, close reading, journal writing, and station investigations)?

How Do I Plan Different Types of Investigations to Integrate Meaningful Learning Experiences?

“Dear Family,

We are learning about raptors. I like raptors. My favorite raptor is the Red-tail Hawk. Raptors are very cool animals. They are none [known] for thar [their] sharp beaks and thar [their] sharp talons. They can tar [tear] thar [their] prey apart. What tipes [types] of raptors do you now [know] about? And what is your favorite raptor? Why? And what features make it a raptor?

Love, Deran”

How Do Investigations Engage Students in Purposeful Observations?

Outdoor observations become purposeful when students connect classroom learning experiences.

Collaboration encourages students to discuss observations and look closer.

Students engage in argumentation, using evidence from observations to support their thinking.

Students observe geometric shapes. This student is recording the spherica shape of salmon eggs in an aquarium

Students use diagrams from informational text to build models of animals that include animal features.

Observations of real animals lead to purposeful reading, writing, speaking, and listening.

How Can Close Reading Support Ongoing Investigations?

	Steps	Example	
Launch Interest	**Choose** meaningful text that supports concepts.	Choose the book *Owls* by Gail Gibbons.	
Fuel Thinking	**Plan** a relevant investigation to support important vocabulary.	Dissect owl pellets. (See the safety note on p. 46.)	
Propel Learning	**Engage** in a **second reading** to focus on important information. **Engage** in a **third reading** to answer questions and extend learning.	Annotate and highlight text. Ask questions. Ask questions. Create a chart or diagram to illustrate understanding.	Diagram of a food chain 

Close-Reading Guide

Launch Interest

What meaningful text can I select to support concepts?

Fuel Thinking

What investigations can I plan to support vocabulary development from the text?

Observations:

Investigations:

Resources:

Propel Learning

Engage in **second** and **third** readings of the text.

What information will students highlight?

What questions might they ask?

Important Information:

Questions:

What will students **create** that requires finding evidence from text?

What related texts can I make available for students to **extend** learning?

How Can Close Reading Support Ongoing Investigations?

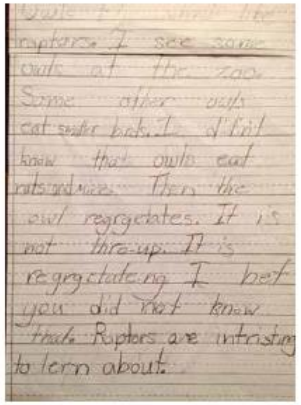
How Do Investigations Engage Students in Purposeful Writing?

Owl seen during a zoo field trip

Third-grade girls dissect an owl pellet and sort bones to determine what the owl ate. (See the safety note on p. 46.)

Students collaborate to discuss how animals in an ecosystem interact to create a food web.

Students use Kidspiration® software to create food chains and food webs.



A first-grader's writing about owls: "Then the owl regurgitates. It is not throw-up. It is regurgitating. I bet you did not know that!"

A high school biology teacher brings an African tortoise to visit a first-grade classroom during a study of animal adaptations (below). A student recorded the habitat, diet, and adaptations of the tortoise in her science journal (left).

Below: Rich observations lead to rich reading and writing experiences. Students engage in further research about different animals. They use informational text to record new information about animal adaptations.

A student brought into class a snail found in her yard, initiating a spontaneous investigation (upper left). The students learned, "When it is moving, an adult garden snail is nearly as long as your middle finger" (Hartley and Macro 2006, p. 8). The student drew a picture in her science journal of the snail on her finger (upper right). Students read informational texts to support vocabulary development with terms such as *soft foot*, *feelers*, and *muscle*. They worked together to draw and label a diagram of the snail in an ongoing investigation (lower left). The investigation became multidimensional as students investigated the live snail (lower right) as well as by reading books and using digital resources.

How Do Investigations Support Webb's Depth of Knowledge?

DOK Level 1: Recall and reproduction

- Requires recall of information such as fact, definition, term, or simple procedure, including following a simple process or procedure.
- Typically requires one step. Example: Recall the fact(s).
- Question: What are the parts of an owl? Name the parts of an owl.

DOK Level 2: Skills and concepts

- Includes mental processing beyond recalling or reproducing a response.
- Requires more than one step. Example: Make observations and infer an explanation.
- Question: What do owls eat? Dissect owl pellets. Observe the bones from the pellet to determine what the owl ate.

DOK Level 3: Strategic thinking and reasoning

- Includes cognitive demands that are complex and abstract with more-demanding reasoning.
- Requires multiple steps.
- Question: How could we design an owl box to help the farmers in our community? Design and build a model owl box to determine the accurate measurements for a specific type of owl.

DOK Level 4: Extended thinking

- Requires high cognitive demand using higher-order thinking processes such as analysis, synthesis, and reflection; involves very complex ideas across multiple content areas.
- Possible question: How can we communicate what we have learned, and what can we do to positively affect our local environment? Make brochures to present information and inform, and build owl boxes to donate to farms.

How Does the Powerful Practices Model Integrate SEPs?

1. **Asking questions (for science) and defining problems (for engineering)**
   How will we know what size to make the owl box? What kinds of owls live in the orchard where we will place the owl box?
2. **Developing and using models**
   How should we design the inside of the owl box?
3. **Planning and carrying out investigations**
   How will we dissect the owl pellet?
4. **Analyzing and interpreting data**
   How will we know what kinds of animals the owl ate? Using information from the data table, how do we know where the raptor's habitat is according to the food source?
5. **Using mathematics and computational thinking**
   Use pattern blocks to model a raptor's wingspan. Measure the blocks with a yardstick and compare students' "wingspans" to that of a bird of prey.
6. **Constructing explanations (for science) and designing solutions (for engineering)**
   We know the owls ate two rodents because we found two rat skulls.
7. **Engaging in argument from evidence**
   I think this feather belongs to a Harris's Hawk because of the markings on the tip of the feather.
8. **Obtaining, evaluating, and communicating information**
   Teach others about our experience through writing, building models, and presenting information.





How Can You Build Integrated Investigations?

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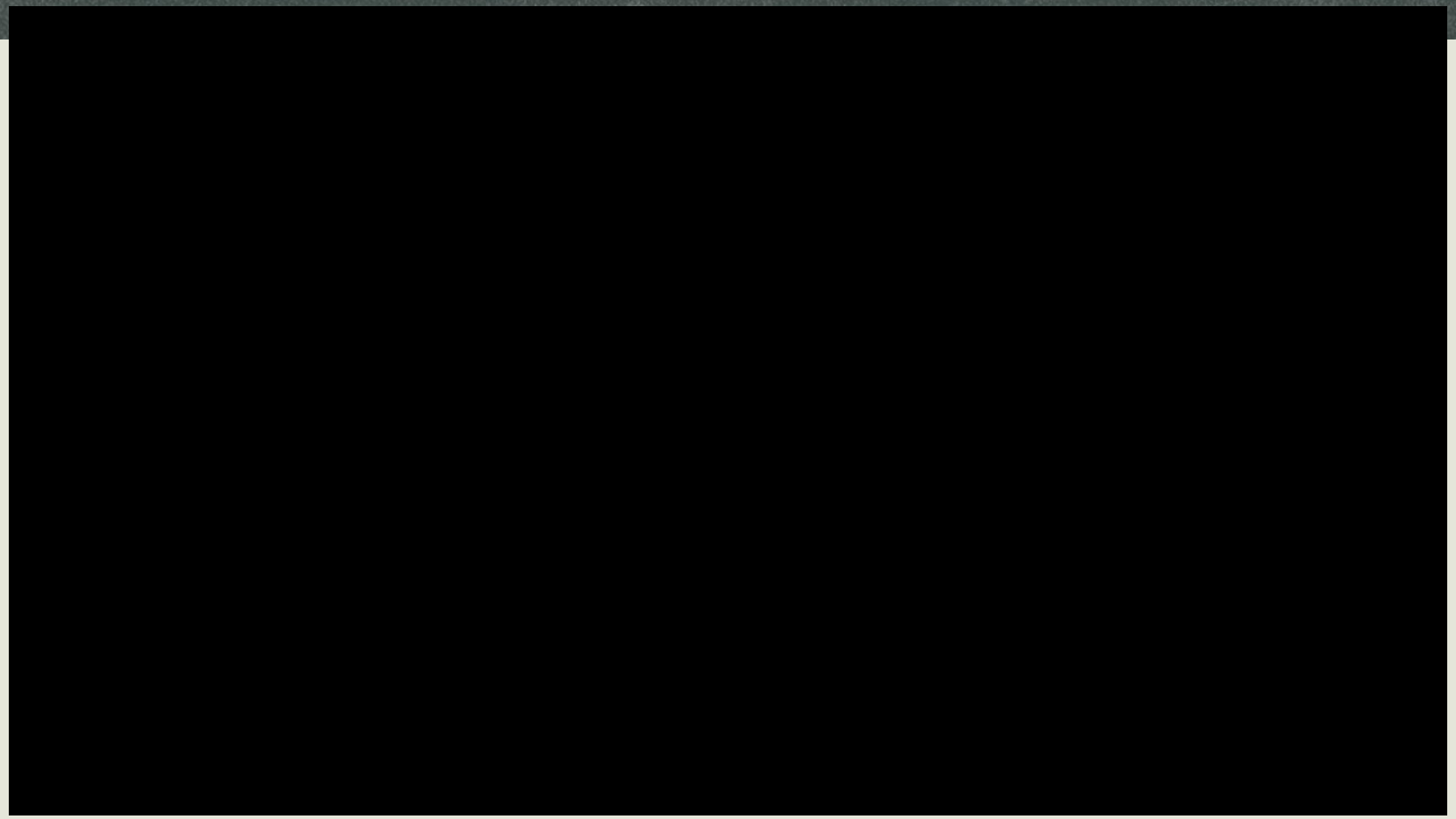


How Can You Build Integrated Investigations?

Create Interest

Student interest may lead to a unit of study about different birds of prey. Students may ask, "How are birds of prey similar and different?" Inviting a guest speaker who works with the local wildlife rescue or accessing live web cams can offer students experiences with real owls and raptors. Dissecting owl pellets gives students a hands-on experience.

Construct Experiences

Reading engaging books such as *Owls* by Gail Gibbons may support a topical study of owls. Students may ask, "How do owls move?" and "Why are owls nocturnal?" Additional books and videos support investigations to study the physical characteristics of owls (for example, the beak, talons, ears, and wings) and compare and contrast owls with other birds of prey.

Connect Learning

A study of interdependent relationships in ecosystems offers the opportunity to ask, "How do plants and animals interact in an ecosystem?" and "How do owls impact our local farming community?" Building model owl boxes connects math and engineering. Students may collaborate, plan, and build real owl boxes to donate to farmers in the local community.

Create

Create a collaborative and dynamic learning environment with rich learning experiences to engage *all* students.

Construct

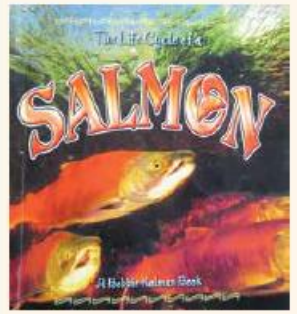
Construct a plan that integrates experiences meeting specific learning needs and academic goals and elicits creative thinking.

Connect

Connect students with opportunities for critical thinking within and beyond the walls of the classroom.

Create Interest

Student interest may lead to a unit of study about the life cycle of salmon. Students may ask, "How do salmon grow and develop?" and "Why do they live in the river and the ocean?" Observing salmon eggs in the classroom helps students see the life cycle up close.



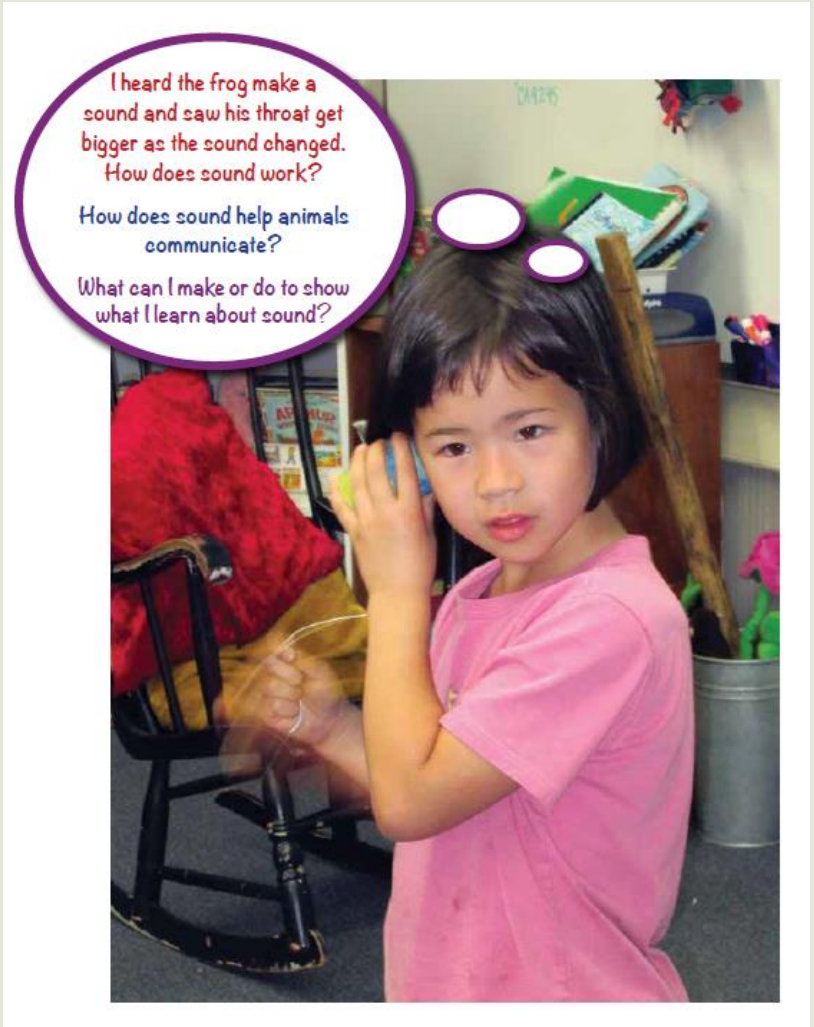
Construct Experiences

Reading engaging books such as *The Life Cycle of a Salmon* by Bobbie Kalman and Rebecca Sjonger may support a topical study of fish or salmon. Students may ask, "What are the parts of a fish?" and "Why do some fish live in a river and others in the ocean?" Additional books and videos support investigations to study salmon or fish in general.

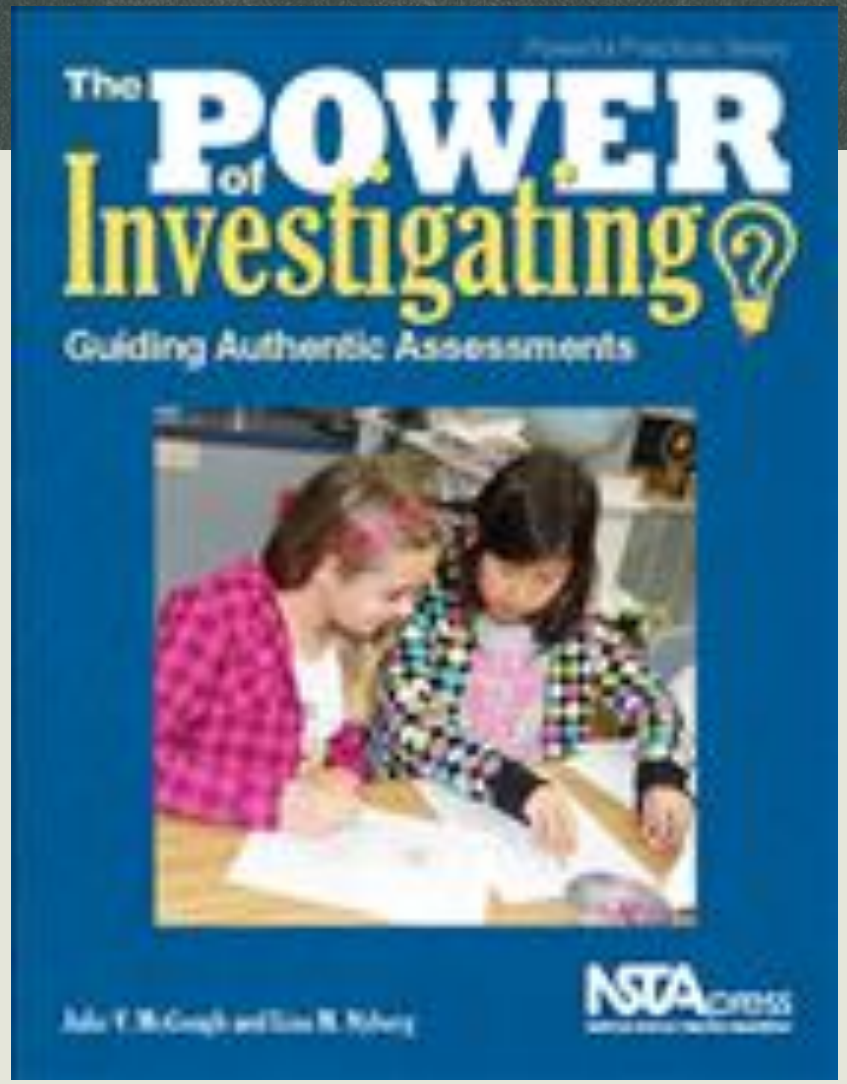
Connect Learning

A study of interdependent relationships in ecosystems offers the opportunity to ask, "What can we do to help the salmon survive in a river in our area?" Releasing salmon raised in the classroom into the local river connects students to the environment. Engage students in educating the community about river pollution. Students may organize a cleanup day at the river.

How Does Investigating Create Opportunities That Lead to Deeper Questioning and Authentic Assessments?



Questions????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