The Power of Questioning: Guiding Student Investigations

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Why Question?

Learn from yesterday, live for today, hope for tomorrow. The important thing is not to stop questioning.

Albert Einstein

(*Relativity: The Special and General Theory*, 1920)

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

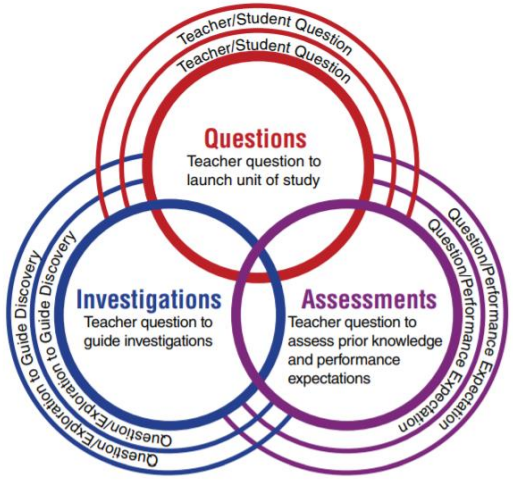
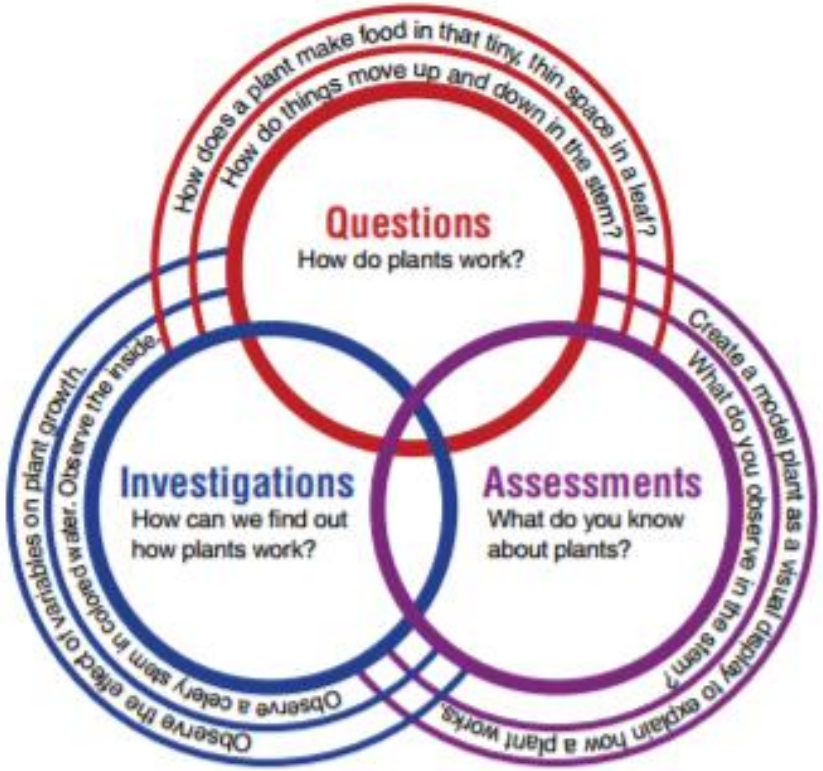


Figure 1.3. Powerful Practices Model: Structure and Function of Plants
An example of the Powerful Practices model filled out during a unit on the structure and function of plants.



Cienna's Discovery

Table 1.1. Standards-Based Learning: Structure and Function of Plants
Examples of standards used during the study of the structure and function of plants. DOK = Depth of Knowledge (see p. 22); ELA, English language arts.

National Standards	Standards-Based Learning
***NGSS*: Life Science** **LS1.A:** Structure and Function ***NGSS*: Engineering** **ETS1.2:** Developing and Using Models ***CCSS ELA*: Reading Informational Text** **RI.7:** Use illustrations and details in a text to describe and explain key ideas ***CCSS ELA*: Speaking and Listening** **SL.2:** Ask and answer questions about key details **SL.4:** Describe things with relevant details **CCR.4:** Present information, findings, and supporting evidence **SL.5:** Add visual displays to descriptions to clarify ideas	***NGSS*** Children learn that plants have internal (xylem, phloem, veins) and external (roots, stems, leaves, flowers, fruits) parts that help them survive and grow by investigating (e.g., planting seeds, placing a carrot top in water) and observing real plants over time (e.g., garden experiences) (DOK Levels 1 and 2). Children develop models to describe phenomena (DOK Level 3). ***CCSS ELA*** Children ask questions about the parts of the plant and how the parts work to help the plant grow. The children use informational text to explain the different internal and external plant parts. Students describe how plants work and present their information to others using the model plant as a visual display to clarify ideas.

How Do Paired Standards Help Students Engage in Higher-Level Thinking?

Developing Questioning Strategies: Types of Questions

- Divergent
  - Multiple answers
  - Open ended question to determine prior knowledge, misconceptions, or possible areas to investigate.
    - What do you know about…?
- Convergent
  - One correct answer
  - Closed ended question to check for understanding of concepts.
    - What does the nervous system do?
- Clarifying
  - Describe ideas in more detail or explain ideas in a different way.
    - How does oxygen get to the organs?
- Probing
  - Explain reasoning and deepen understanding.
  - Analyze ideas.
  - Compare and contrast.
    - How are the nervous system and the circulatory system different?
    - What would happen if…?
- Justifying and Extending
  - Hold the learner accountable for their thinking.
  - Providing evidence requires the learner to support and extend their ideas.
    - Why do you think that?
    - What evidence supports your ideas?

What Does a Discussion Sound Like Using These Types of Questions?

Developing Questioning Strategies

Table 1.2. Types of Questions

Question Type	Question Purpose	Teacher Questions
Divergent (Multiple answers)	• Open-ended questions may determine prior knowledge, misconceptions, and possible areas to investigate.	• What do you know about plants? • What do you know about animal life cycles?
Convergent (One correct answer)	• Closed-ended questions check for understanding. • Review concepts.	• Where are the roots? • What are the stages of a chick's life cycle?
Clarifying	• Describe ideas in more detail. • Explain ideas in a different way.	• How do roots grow? • How does the chick hatch from the egg?
Probing	• Explain reasoning and deepen understanding. • Analyze ideas. • Compare and contrast.	• Are the roots on a tree the same as the roots on a carrot? • What if the chick egg is cracked before it is ready to hatch?
Justifying and Extending	• Hold the learner accountable for their thinking. • Providing evidence requires the learner to support and extend their ideas.	• Why do you think that? • What evidence supports your idea?

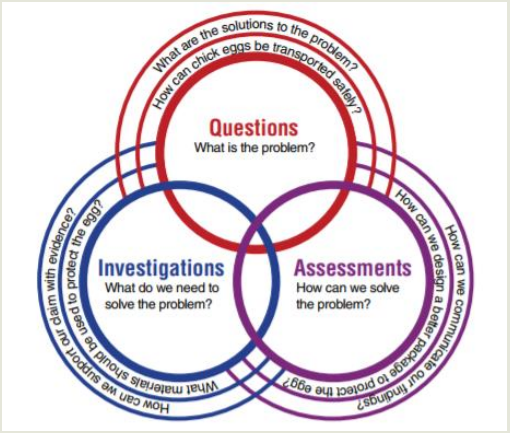
Wait Time

- When students are given wait time of three seconds or longer
  - the length of the student responses increases,
  - students ask more questions,
  - students show more evidence of attending to each other,
  - failures to respond decrease,
  - a greater number of students participate, and
  - achievement improves on written measures where the items are cognitively complex

(Mary Budd Rowe, 1986)

Webb's Depth of Knowledge

National Standards	Standards-Based Learning
***NGSS*: Life Science** **LS1.B:** Growth and Development of Organisms ***NGSS*: Engineering** **ETS1.1:** Asking Questions and Defining Problems **ETS1.2:** Constructing Explanations and Designing Solutions ***CCSS ELA*: Writing** **W.6:** Use technology to produce and publish writing as well as to interact and collaborate with others. **W.7:** Conduct short research projects that build knowledge about a topic. **W.8:** Recall information from experiences or gather information from print and digital sources. **W.9:** Draw evidence from informational texts to support analysis, reflection, and research ***CCSS ELA*: Speaking and Listening** **SL.1:** Engage effectively in a range of collaborative discussions, building on others' ideas and expressing their own ideas clearly.	***NGSS*** Students observe that animals have unique and diverse life cycles (DOK Levels 1 and 2). Students ask questions about how the packaging and container could be modified to improve the condition of the eggs that are shipped from the hatchery (DOK Level 3). Students design containers to test possible solutions to the problem and communicate findings to the hatchery (DOK Level 4). ***CCSS ELA*** Students use tablets and computers to conduct research and build knowledge of packaging and shipping processes. Students interact, collaborate, and pose questions to further discuss design solutions as they test models. Students recall information from experiences and resources to write letters to the hatchery offering suggestions to improve the shipping process of live chick eggs.



DOK Level 1: Recall and reproduction

- Requires recall of information such as a 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 stages of the chick's life cycle? Name the stages of the chick's life cycle in developmental order.

DOK Level 2: Skills and concepts

- Includes mental processing beyond recalling or reproducing a response.
- Requires more than one step. Example: Make observations. Infer explanation.
- Questions: What could have happened during shippping to damage the eggs? Describe the eggs and the container. Examine the carton that the chick eggs came in and the materials used for shipping.

DOK Level 3: Strategic thinking and reasoning

- Includes cognitive demands that are complex and abstract with more demanding reasoning.
- Requires multiple steps.
- Questions: How could the shipping package be modified to improve the condition of the eggs that are delivered? Design, build, and test the model and justify why it was successful or unsuccessful.

DOK Level 4: Extended thinking

- Requires high cognitive demand using higher-order thinking processes such as analysis, synthesis, and reflection; involves very complex ideas crossing multiple content areas.
- Requires multiple steps over time.
- Questions: How will you communicate your findings and persuade the company to modify its current packaging design? Write to the company persuading them to improve packaging design (may include a prototype).

What's The Difference Between Asking Questions and Defining Problems?

- The National Research Council (NRC 2012) makes a distinction between asking questions (scientists) and defining problems (engineers).
  - Scientific questions often arise from curiosity and wonder related to how the world works.
  - Engineering questions emerge to define a problem and develop a successful solution.

Who Are My Students and How Do They Think?

Thinking About Analysis

Some students see the big picture *and* the component parts of a concept quickly. Don't call on a person like this too early in the discussion. He or she might take the conversation to the big idea too soon—before you have cultivated new ideas or perspectives from other students. Calling on this person at just the right moment can help students deconstruct and reconstruct concepts or transition to the next logical step.

"Estevan, what do you think is happening inside the egg?"

Thinking About Big Ideas

Some students see the big picture and may begin planning projects without conceptualizing all of the important details. Calling on this enthusiastic type of learner at just the right moment may help launch the next investigation!

"Lacee, what do you think we could make to help us understand this idea better?"

Thinking About Questions

Some students are full of wonder and naturally inquisitive. These students demonstrate a strong drive to explore and want to observe items closely. Calling on this kind of student at just the right moment may spark new questions or create an opportunity to investigate ideas further.

"Michelle, how is the life cycle of the ladybug you found different from the life cycle of a chick?"

Thinking About Perspective

Some students look at things differently or from a unique perspective. Calling on one of these students at just the right moment may help you dive deeper into the discussion or articulate connections between related concepts.

"Jadee, how does a chick come out of an egg differently than a caterpillar comes out of an egg?"

Thinking About Details

Some students pay close attention to organization, sequence, and precise language. Call on this type of person to clarify abstract thoughts or provide missing pieces of information when needed.

"McKenzie, how can we organize the information to show the life cycle of a chick?"

Thinking About Meaning

Some students listen carefully and perceive relationships well. They show awareness of context clues and like to clarify meaning. These students can help define words in context or synthesize the contributions of others.

"Michael, the text said that the hen sits on her clutch after she lays the eggs. What do you think clutch *means?"*

Thinking … Who Needs a Box?

Some students make conceptual leaps and offer a unique problem-solving perspective! Students like this may visualize concepts before all the pieces are in place. Calling on one of these people at just the right moment may help lighten the discussion and add humor or open the door to new possibilities.

"Christine, chicks do not have teeth to chew their food. How will the chick eat?"

Who Are My Students and How Do They Think?

Figure 2.2. Observation Checklist: How Do My Students Think?

The teacher needs to know his or her students, their interests, their learning needs, and how they think.

An **observation checklist** can help you analyze how students think so you can plan questions to keep the discussion moving.

Record observations of students as they work independently, work in groups, participate in discussions, and interact with assigned tasks. When a student displays one of the characteristics listed, write his or her name in the box. Add tally marks next to the name if students display characteristics multiple times. Record observations over a week during different kinds of interactions and tasks.

Tip: Use different-color pens to record observations, signaling one color for each type of interaction or task (e.g., red for group work, blue for hands-on task, etc.).

Thinking About Analysis • Sees the big picture • Sees the component parts • Sequences ideas logically • Solves problems eagerly • *Can deconstruct and reconstruct concepts or ideas*	
Thinking About Big Ideas • Dives in without conceptualizing • Shows initiative and is a self-starter • Is eager, enthusiastic, sometimes impulsive • *Is always ready to launch the investigation*	
Thinking About Questions • Is naturally inquisitive • Is full of wonder • Has an imagination without limits • Has a strong drive to explore and know • *Is always willing to investigate further*	
Thinking About Perspective • Looks at things from a unique perspective • Communicates ideas in a different way • *Articulates connections between related concepts*	
Thinking About Details • Notices organization • Pays attention to time and sequence • Clarifies abstract thoughts • Uses precise language • *Contributes missing pieces of information when needed*	
Thinking About Meaning • Shows awareness of context clues • Likes to clarify meaning • Perceives relationships • Observes and listens carefully • *Synthesizes contributions of others*	
Thinking Outside the Box • Makes conceptual leaps • Has a unique problem solving perspective • Visualizes concepts before all the pieces are in place • *Opens the door to new possibilities*	

How Do I Provide Opportunities for ALL Students to Participate?

Silent Period
A student is not speaking in class.

⇨ **Teacher:** "Show me the root." (Response: Pointing to the plant part)

Beginning Level
A student speaks one or two words at a time.

⇨ **Teacher:** "Is this the *root* or the *stem*?"

Intermediate Level
A student is beginning to share short sentences.

⇨ **Teacher:** "Describe the root of the plant."

Advanced Level
A student is using academic language to explain concepts.

⇨ **Teacher:** "Explain how the plant gets water."

What Does a Student Response Sound Like Using These Questions Put In Context With a Model?

How Do I Build a Collaborative Learning Community to Support Questioning?

Table 2.1. Setting Expectations for Dynamic Discussions

Seating Room Arrangement	Respect for Self and Others	Nonverbal Communication Signals	Possible Types of Interaction
• Sitting in a circle • Small group discussions at tables • All students facing forward • Assigned seating vs. choice seating	• One person talks at a time • Everyone listens • Participants are respectful of each other's learning • Participants support each other • Dynamic community environment	• Raising hand to speak • *C* on forehead to signal making a connection • Holding two fingers up to signal quiet • Thumbs up to agree • Thumbs down to disagree	• Asking clarifying questions • "I agree because …" • "I disagree because …" • "I have a connection to what ___ said." • "I understand what ___ said but I also think …"

Students learn how to interact in a discussion through modeling, teacher think-alouds, and sentence frames.

Modeling: A teacher may say something like, "Michael, that is an excellent question. I don't know the answer. We need to do some more research. I think I know of a book in the library that might help us."

Teacher think-aloud: "I think we may need to find some resources to help us understand the parts inside this bird of paradise stem and how it works. Lukas, please bring the tablet from the investigation station."

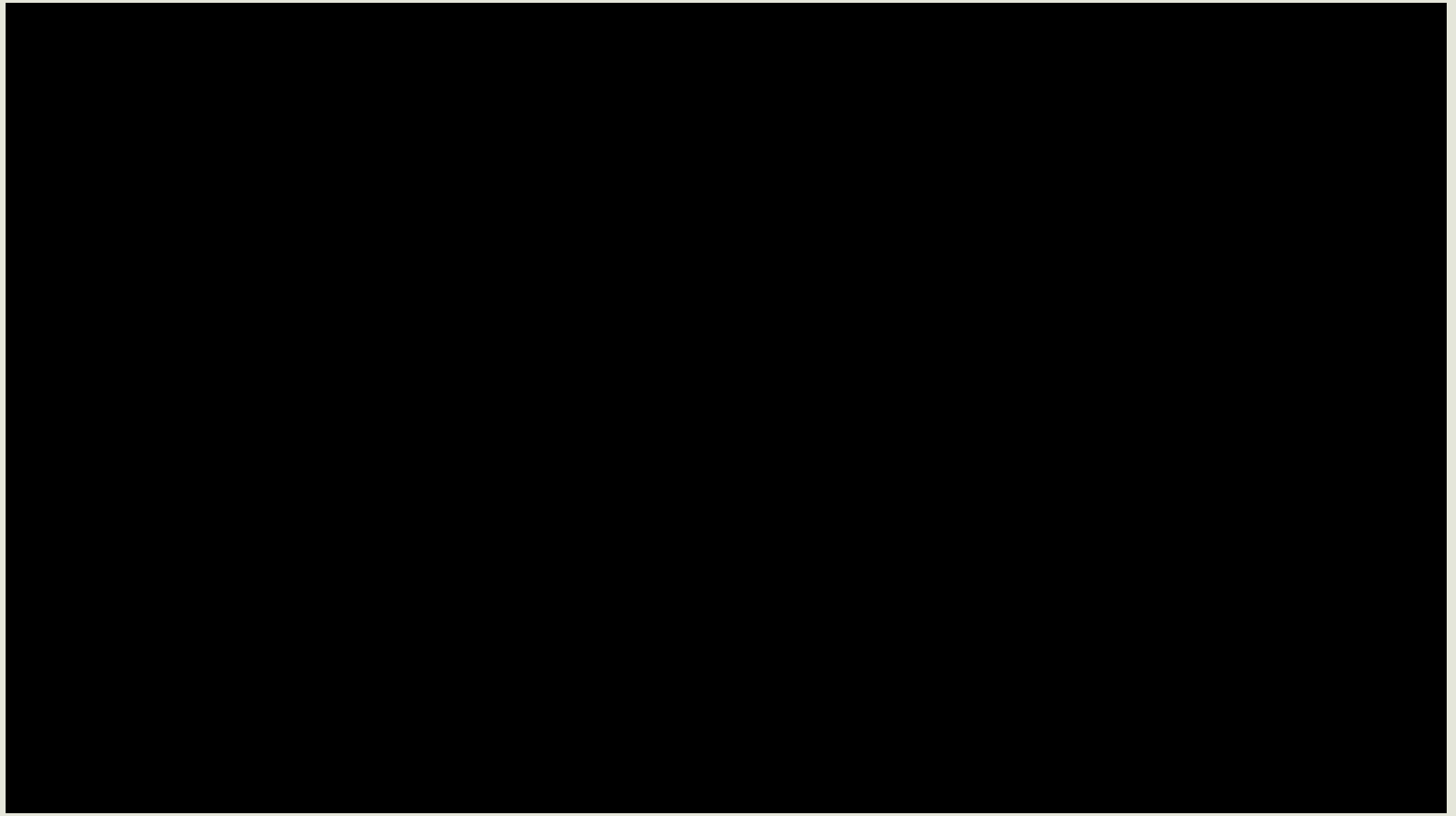
Sentence frames: Sample dialogue posted on charts may be helpful when students begin learning the skills of questioning. The charts can be taken down as the students build confidence and become more skilled in academic discourse.

"I agree with _____ because _____."

"I disagree with _____ because I was thinking _____."

Students place their hands in the shape of a *C* on their foreheads to signal they have connections.

What Does a Collaborative Learning Community Discussion Sound Like?



Organizing Resources and Tools for Investigation Stations

Nonfiction Library

- Provide a focused area for a different type of reading. Materials may be gathered from the school or public library, teacher collections, internet resources, or materials brought in by students.
- Designate an area for informational text including books, magazines, and other text resources to invite students to read, research, and investigate.
- Organize informational text into categories for easy student access. Possible categories: Animals, life cycles, habitats, Earth science, physical science, science magazines.

Vocabulary Resources

- Integrate vocabulary into student work displays.
- Label items on display for observation (e.g., experiments, investigations, animal study).
- Organize vocabulary in pocket charts or displays to illustrate key words in context (e.g., seed, roots, hair roots, stem, leaves, veins, flower).
- Present terminology in context (with pictures or actual objects).
- Introduce terminology during learning experiences to maintain connection to the content.
- Create an active word wall for new academic vocabulary and content vocabulary as it is introduced for student reference.

Observation Area

- Organize and label items to observe.
- Display relevant books with real objects.
- Items may be placed by a teacher or brought in by students from recess or home. If you are studying plants, bring in plants. When you cannot bring in the items, use pictures and technology resources.
- Example: Sunflower head, sunflower seeds, sprouting sunflower plant, and books on sunflowers; pinecone, bark, sap, pine needles, books on pine trees.

Observation Tools

- Organize and label tools for observation.
- Observation tools should be organized and available for students to use each day. Specifying a place in the classroom to house these items offers a learning space for purposeful work.
- Possible items: Hand lens, petri dish, tweezers, microscope, digital microscope, and small containers with air holes (for animals that visit the classroom).

Data Collection Tools

- Organize and label tools to collect data for easy access.
- Students may find items to measure or compare on the playground or bring in interesting finds from home. These items serve a learning purpose when tools are available to use each day.
- Possible tools: Rulers, scales, measuring tape, computers, cameras, and tablets.

Writing Supplies

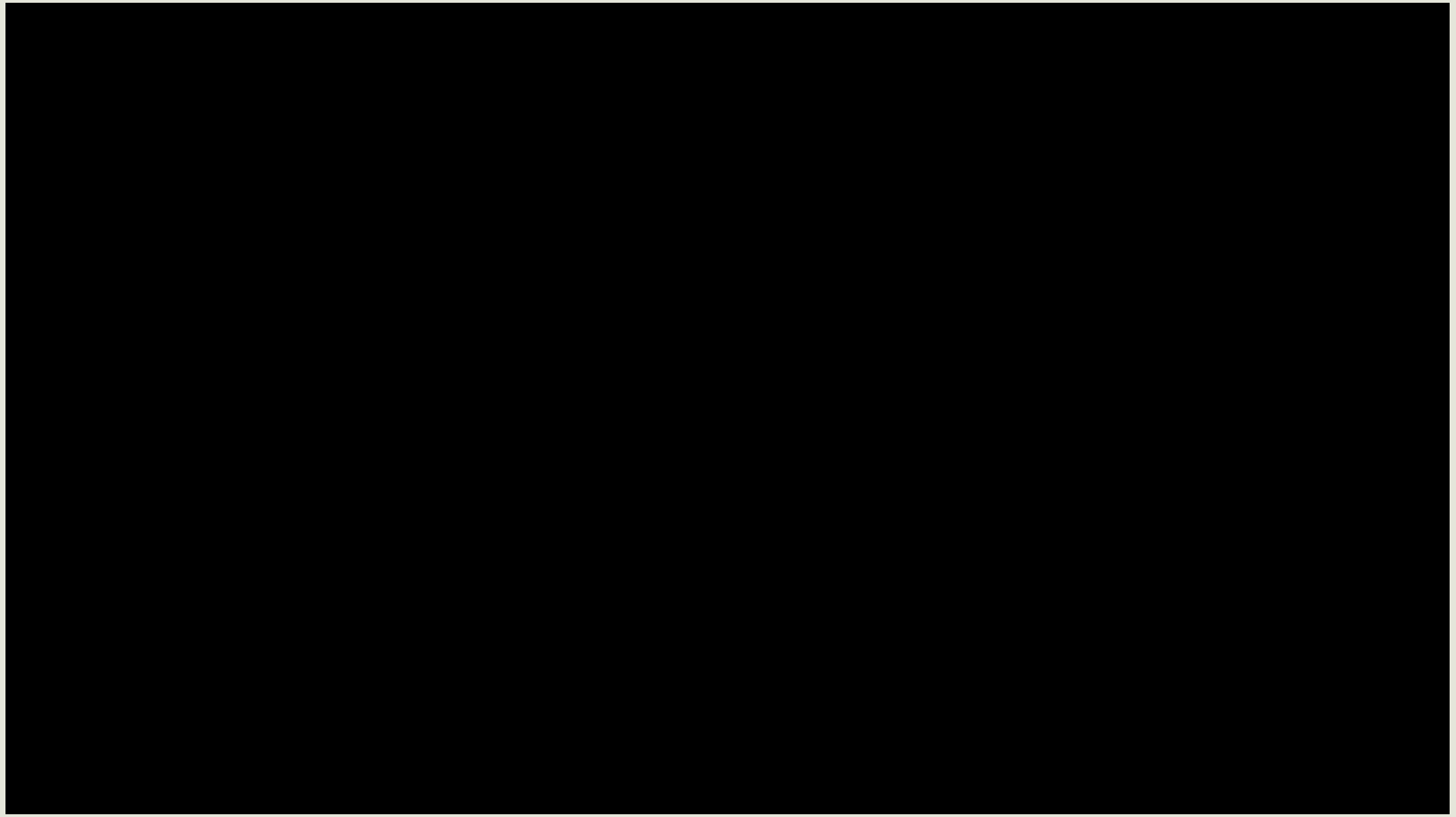
- Organize and label supplies to record observations.
- Students may have individual supplies, but additional supplies should be organized and available for student projects and investigations as they arise.
- Possible supplies: Paper, folders, paper trays, pencils, colored pencils, glue sticks, scissors, journals, computers, and tablets.

How Do I Implement the Power of Questioning?

What Does a Metacognition Discussion Sound Like When Students are Questioning About Questions?

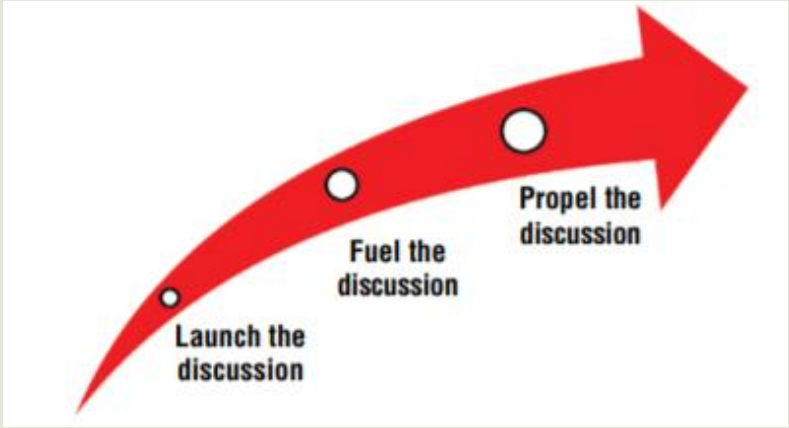
- **Access further details:** Use a probing question, such as, “When you see things closer, how does that help you learn about it?”
- **Clarify what a student means:** Use a clarifying question, such as, “What do you mean by ‘know what they have’?”
- **Offer students time to think:** Ask an open-ended question, such as, “Seeing what …What do you think?” and allow wait time.
- **Transition the discussion:** Take the discussion from metacognition (about spider investigations) to the current topic of study (plants) by asking clarifying questions: “When we drew the tarantula and drew a line and wrote something, what were we labeling? What were we trying to identify?”
- **Clarify purpose:** Review the strategy of drawing and labeling the parts of something to help you learn about it and understand how it works.] Check for understanding: Use a convergent question, such as, “What is one part of the plant?” to identify the parts of a plant.

What Does a Metacognition Discussion Sound Like When Students are Questioning About Questions?



How Do I Connect Discussions Within a Unit of Study?

- Before the discussion, I need to
  - choose a topic or core idea;
  - focus the topic or core idea with the content standards (TNSS and TNELA);
  - use the unit planning guide to plan and organize questions, investigations, and assessments; and
  - decide on a question to launch into Powerful Practices.



How Do I Connect Discussions Within a Unit of Study?

Launch

"Plants are all around us. We even eat different parts of plants!"

"What do you know about plants?"

- **Questions introduce concepts** and launch purposeful discussions.
- **Questions invite students to communicate** prior knowledge. Make note of student misconceptions.
- **Questions inspire students** to share their questions.

Fuel

"Yesterday we talked about the parts of a plant."

"What is the purpose for each part of the plant?"

- **Questions work as a catalyst** to fuel the discussion. Focus the question on real objects or something tangible (e.g., celery stems in colored water).
- **Questions fuel the discussion** as you focus investigations and use resources.
- **Questions involve students** in developing new questions, collecting data, and recording observations.

Student plant model shows water and nutrients inside the stem.

Propel

"Observe the inside of a bird of paradise stem, and notice the tubes. How does water move inside of a stem?"

- **Questions lead to further investigations.** Investigate bird of paradise stems. Cut the stem open to see what is inside.
- **Questions lead to performance assessments** that help students communicate understanding. Research other parts of a plant and how they work. Build a model plant to explain the process.
- **Questions lead to local and global connections.** "How can students communicate their understanding?" Present the model plant to community members who helped design the school garden.

Launch the discussion

What will draw my students into the discussion?

_____

_____

Fuel the discussion

What objects, investigations, or resources will help my students construct understanding and develop more questions?

Observations _____

Investigations _____

Resources _____

Propel the discussion

What types of questions do I need?

Convergent _____

Divergent _____

Clarifying _____

Probing _____

Justifying _____

Extending _____

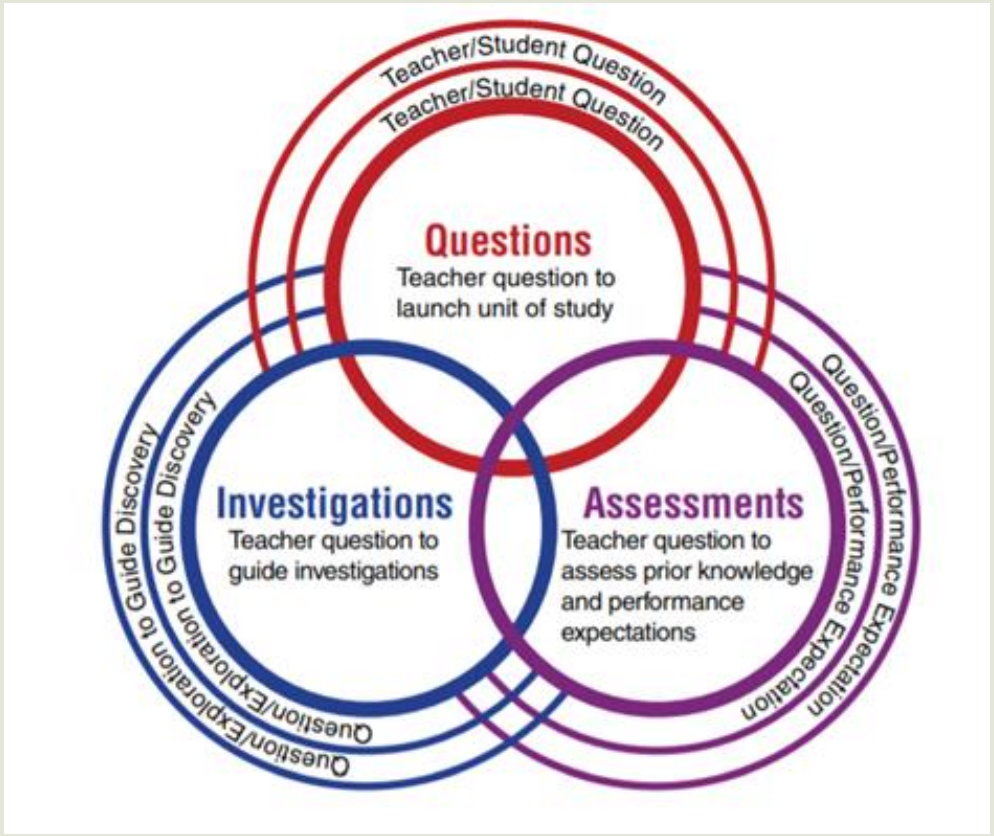
How will I **connect** this discussion to the next discussion?

_____

What opportunities may **extend** this unit to the community?

_____

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



Questions????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Guiding Student Investigations
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