Session 6: Conversations and Questions

Overview

This session is one of four *Apply and Refine* sessions, which can be done in any order. The focus of this session is on conversations and questions, and the key role they play in supporting learning and meaning making of ideas and concepts for learners. Conversation can be a window into learners' prior knowledge, skill-level, personality, previous experience, and ability to articulate ideas. Three patterns of talk are introduced through role-plays that depict typical interactions between educators and learners, followed by discussions about the impact on learners when an educator sees his/her role as either "sage on the stage" or "guide on the side." Students then discuss how they may influence the types of conversations they have with their learners through the questions they ask and how they follow up on those questions.

Session Objectives

In this session, students:
  - Discuss the purpose and value of conversations in the learning process;
  - Read short excerpts from the research literature to become aware of such ideas as, IRE (Initiate, Respond, Evaluate), and the value of (1) peer to peer conversations, (2) dialogue in learning, and (3) guidance in learning science;
  - Experience and reflect on the different effects of focused and broad questions on thinking and discussions with learners; and
  - Note the impact on learners when an educator sees his/her role as either "guide on the side" or "sage on the stage."

Background Information for the Presenter

Learning Occurs through Conversation

Learning results from a combination of reflecting on and making connections between prior experiences, new experiences and content, motivation to learn, and social interactions. As many have experienced in their own learning and teaching, conversation plays a key role in facilitating social interactions around learning and assisting in meaning making for ideas and concepts. Learning occurs through discourse within social interactions (Rogoff, 1998; Vygotsky, 1978).

"Meaning emerges in the interplay between individuals acting in social contexts and the mediators that are employed in those contexts" (Schauble, Leinhardt, & Martin, 1997, p. 4). Tools, language, signs, symbols, and peers and experienced individuals are mediators. In other words, human thinking is shaped by the social activities and use of the materials and symbols invented by culture, which in turn are temporally and geographically influenced. Vygotsky (1978) detailed the importance of discourse further by arguing that higher mental functions have social origins that are first expressed between individuals before they are internalized within the individual. In other words meanings are rehearsed and made explicit as a result of conversations and interactions

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between people before becoming internalized by the individual. In the sociocultural viewpoint, learning relies on conversation. For learners, engaging in conversations can foster more generative thinking and enable them to practice dialogic skills, such as asking questions and communicating ideas in an effective manner. It can be a way for them to process information and make social connections. These thinking and dialogue skills form the basis of active, analytic, individual thought, and allows individuals to develop their ability to communicate their ideas. In museums, educators negotiate this interplay within the social activities and rely extensively on conversations as a key form of mediation. For educators, conversation can be a window into their learners' prior knowledge, skill-level, personality, previous experience, and ability to articulate ideas.

It's important to keep in mind that talking about conversation starts us thinking about other aspects of a learner's culture that can influence learning. The culture of the learner can be the culture of a society, ethnic group, or a country and also includes the culture of the classroom, family, group of friends and the resulting activities, routines and common experiences that people in each of those communities has. Each of these cultural components can influence the ways that ideas are conceptualized, modeled, and understood.

Patterns of Facilitated Conversations

In informal learning environments, conversations occur between educators and learners, as well as between learners themselves—as peer-to-peer conversations and parent(s)-child (ren) conversations. Educator-learner conversations are considered to be facilitated conversations. To aid analysis of conversations, researchers look at who is talking and what they are saying—how they contribute to the conversation, and then identify patterns in this exchange. There are three patterns of talk that are most common, and will be explored further in this session (Dawes, 2004; Scott, 1998; Scott, Mortimer, & Aguiar, 2006). Most of the literature on educator talk and discourse is drawn from research in schools simply because there are more studies available. There is some research that explores interactions in informal environments, and these investigations provide evidence that informal educators also use these three patterns of talk (see for example, King, 2009; Tal, 2006; Tran, 2007). So for now, we borrow from classroom research as we consider the applicability of the findings and ideas on practice in informal environments. Descriptions of the three patterns of talk follow.

1. Educator monologue. Educator explains, describes, clarifies, identifies, and questions. In an Educator Monologue, the educator is doing most of the talking, though the turn taking (i.e., whose turn it is to talk) may alternate between educator and learner. In either case, the educator's turn is usually longer than the learner's, and the educator ends up doing most of the explaining, describing, clarifying, identifying, and questioning. The educator dominates the conversation with scientific views and explanations. It is perceived as an efficient way of communicating scientific knowledge, though it is criticized for expressing only one viewpoint and not allowing learners to articulate their understanding of the ideas.

2. IRE or IRF. There are two variations to this pattern. In the IRE variation, the educator **initiates** the conversation with a question or comment, the learner **responds**, the educator **evaluates** the response, and then repeats the pattern with another question (Lemke, 1990; Mehan, 1979). Also, the learner's response may be short answers, while

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the educator's evaluation may be long and elaborate on the learner's response. The second variation to this pattern is IRF, the educator **initiates** the conversation with a question or comment, the learner **responds**, the educator solicits for **follow up** ideas and comments from the learner, and then the pattern repeats with **response** and **follow up** (Sinclair & Coulthard, 1975). In both cases, the turn-taking switches back and forth between educator and learner regularly, and the educator directs the conversation and makes knowledge public. This pattern, and the IRE variation in particular, has been criticized for failing to provide learners with an opportunity to articulate their own understanding and express themselves in the language of the discipline (Alexander, 2005 ; Wellington & Osborne, 2001). On the other hand, it has been argued that such dialogues can serve as a way to extend the learner's answer, to draw on its significance, or to make connections with other parts of the learner's total learning experience (Wells, 1999)

3. Reflective Discourse. Educator facilitates a conversation where learners and educators pose questions, respond to one another's comments and questions, and learners seek to understand each other. In a Reflective Discourse pattern, the educator and the learner are talking back and forth, and both are initiating, responding, and following up on each other's comments. The learner is expressing her or his own thoughts, ideas, and questions. If there is more than one learner, they are also talking with each other and trying to understand the thinking of another. The educator and learner engage in a back-and-forth exchange, asking and answering one another's questions, and trying to understand the thinking of the other person (van Zee & Minstrell, 1997). It offers the learner the opportunity to voice her or his everyday views of the world in common language, but requires the assistance and guidance from more knowledgeable individuals to make connections between everyday views and scientific views (Scott, et al., 2006).

These patterns of talk are neither intrinsically good nor bad; their merits and demerits derive from the reasons for and ways they are used to support and achieve intended goals. In teaching science, there's often a tension between directing the conversation to communicate the views of science and being an equal contributor to the conversation to encourage everyone to voice their views. The opportunity for learners to talk and share their thinking is necessary for learning science, but learning science also requires understanding and speaking the language of science, which educators need to model for learners. It's important for learners to have the opportunity both to make explicit their everyday ideas and to apply and explore newly-learned scientific ideas through talk and other actions *for themselves* (Scott, et al., 2006).

The fundamental point here is that "meaningful learning involves making *connections* between ways of thinking and talking…between everyday and scientific views" (Scott, et al., 2006, p. 622). For instance, an educator may begin with Reflective Discourse to give learners a chance to express their everyday views in order to motivate and encourage them to be engaged, to legitimize their ways of thinking, and probe their prior knowledge. The educator may then shift to IRF to draw out more of learners' thinking and guide the expressions of their understanding toward scientific views. The educator may then transition into Educator Monologue to model how to voice and connect learners' everyday ideas in scientific language, and then finish with more Reflective Discourse to give learners the opportunity to practice using scientific language.

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Questioning Strategies

Questioning is a vital and powerful teaching strategy, a crucial component of just about any teaching and learning situation. This is especially the case when learning situations derive from firsthand experience, and reflection on that experience is used to develop and refine concepts. Questions can open doors at every stage of the learning experience—inviting learners into activities and ideas by creating interest in a new topic, helping guide explorations, introducing new concepts, and encouraging learners to apply their ideas to different situations. Skilled instructors use questions to find out what learners think and draw attention to conflicting ideas. Well-sequenced questions can initiate the sharing of ideas, encourage divergent thinking, help learners recall prior knowledge, allow them to synthesize new information, and help guide logical thinking.

There's an art to questioning strategies and to balancing the amount of asking and telling used in a teaching situation. There's no one formula for what this balance should be and it changes from situation to situation. Experience and practice can hone educators' expertise and questioning know-how. Skilled educators use questions to find out what learners think, encourage discussion, and draw attention to diverse viewpoints and interpretations. However, one can also observe veteran educators who do not take advantage of questioning strategies that could elevate their teaching to interactive learning experiences, but instead resort to perfunctory question-and-answer drills.

Research indicates that educators who are specifically trained to ask high-quality questions show significant improvement in constructing and using such questions in teaching situations (Angletti, 1991, as quoted by Cecil 1995). Reflection and analysis of the effect on learning of various kinds and sequences of questions is essential for educators to develop this type of expertise.

Questions that Encourage or Discourage Discussion

An analysis of questioning strategies can begin with noting the effects of using focused and broad questions during a discussion. The model lesson in this session demonstrates how using focused questions, that have specific, prescribed answers, can shut down a discussion by requiring learners to try to guess what the teacher is thinking. In contrast, beginning the conversation with broad questions, that have multiple acceptable answers/responses, can encourage more learners to participate and offer various ideas for the discussion. Of course, if consensus has been reached as the result of a discussion, it can be appropriate to wrap-up with focused questions that help learners summarize their ideas and conclusions. Once an instructor develops a feel for how these questions affect learners, they can then make thoughtful adjustments to their questioning strategies during their teaching.

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Considering Goals When Asking Questions

When planning for questions, it is also important to consider the educator's purpose or possible goals for engaging the learner in a particular teaching situation. When beginning a new activity or science topic it's often useful to engage learners in observing and noticing details. Questions such as, "What did you notice when…?" can be used to guide learners to make certain observations, but should be broad in order to encourage multiple points of view. Questions such as, "What do you think will happen if…?" can be used to stimulate productive activity during an investigation. Once learners have explored a phenomenon or performed an investigation, questions can then be used to guide learners to make comparisons or quantify their observations. Given adequate experience and exploration of a topic or phenomenon, learners may then be ready to draw conclusions and make sense of their investigations, responding to questions, such as, "What do you think is the explanation for…?" or "Why do you think this happened?" can be used to encourage sense-making. Questions can be used to challenge learners to apply what they've learned in order to generalize their knowledge or test their hypotheses. Asking learners to reflect on their thinking and investigation processes helps them become more aware of their own strengths and weaknesses in the subject area, as well as encouraging them to take charge of their own learning.

Role of the Educator

The final factor considered during this session, that can definitely impact an educator's questioning strategies, is how they view their role in the learning process. A "sage on the stage" type of educator has the point of view that it is their responsibility to impart or transmit knowledge directly to learners and that the educator or text must provide the necessary information for understanding. This view of the learning process can emphasize rote memory and regurgitation of ideas from sources other than the learners themselves. A "guide on the side" type of educator embodies a more constructivist view of learning—one which accepts that learners must be encouraged to create their own personal frameworks through discussion and interactions with materials and various sources—in order for them to develop a deeper understanding that can be flexibly applied to different learning situations.

Although education researchers have identified many categories and subcategories of questions, we've chosen to focus on two main groups. These two groups are "**broad**" and "**focused**" questions, also referred to in some education literature as "open" and "closed," or as "broad" and "narrow." By this distinction, we in no way intend to classify these question types as either good or bad. The activities in this session focus on the appropriate use of both types of questions. The emphasis is on analyzing the impact of both question types on the thinking and behavior of learners, and using this information to help decide how and when to best use such questions. In addition, we focus on the appropriate *sequencing* of questions, both to guide learners through learning cycle-based explorations, and to help lead discussions. We also explore the effects of an educator's perceived role on how they approach questioning.

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Session at a Glance

Task	Description	Estimated time (in minutes)
Quick Write & Discussion: *Key Characteristics of learning conversations*	Students reflect on and write about their thoughts from the reading. They share their ideas on the role of conversations in learning and determine key characteristics of learning conversations.	20
Research Discussion: *Learning & Talking*	Students do a jigsaw discussion about talking and learning. They include their own reactions to the information and questions they have about it, leading a discussion on the topic within their group.	30
Activity: *Types of Conversations*	Three brief skits are acted out, depicting the patterns of conversations between an educator and learners.	45
Research Discussion: *Questions, Teachers, & Discussion Map*	Students are introduced to broad and focused questions and discuss how educators may influence the types of conversations they have with their learners through the questions they ask and how they follow up on those questions.	30
Science Briefing: *Deep sea/Adaptations* *OR* *COSIA Skull Cart Activity*	Students learn about the deep-sea environment and adaptations as they participate in an interactive PowerPoint science briefing presentation or the COSIA Skull Cart Activity highlighting questioning strategies, the Discussion Map, and the interplay between the kinds of conversations.	35
Homework	Readings & tasks are assigned.	5
	TOTAL: 2 hrs 50 minutes	**170**

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Materials Needed

For the class:
– PowerPoint presentation for Session 6: Conversations & Questions
– 1 digital projector
– Copy of Marine Skull's Cart Activity write-up
– Materials to do Marine Skull's Cart Activity (see activity write-up)

For each participant:
– 1 copy of the "Types of Questions Defined" sheet
– 1 copy of "Discussion Map"
– 1 copy of "Questions and the Learning Cycle"

For each small group of 4–5 students:
1 set of the following research cards:
– Research Card #1: The Value of Dialogue
– Research Card #2: IRE (Initiate, Respond, Evaluate)
– Research Card #3: Peer to Peer Discourse
– Research Card #4: Value of Guidance in Learning Science
– Research Card #5: Reflective Discourse and Monologues

For the Skits:
– 4 copies of each of the three different Skit Scripts—one for yourself and one for each of the three skit participants
– 1 copy of each Role-Play Script Worksheet for each of the three skits, for each student
– Optional:
    o 1 magnifying lens
    o 1 square cm piece of cardboard
    o sea otter pelt (or stuffed sea otter toy)
    o picture of sea otter
    o 1 abalone and 1 mussel shell

Preparation of Materials

1. Duplicate handouts, 1 per student:
    – "Research Statements"
    – "Types of Questions Defined"
    – "Discussion Map"
    – "Questions and the Learning Cycle"
    – "Role-Play Script Worksheet"

2. Duplicate scripts, 4 copies of each skit:

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–   Make four copies of the scripts for all three skits—one for yourself and three for the role-play volunteers. For each role-play, highlight the lines for the respective actors.

3. Decide on Science Briefing or Marine Skull Cart Activity.
–   Decide if you will do the Marine Skulls Cart, or a different activity you are familiar with, or the Interactive Science Briefing Presentation.
–   If you choose to do the Marine Skull's Cart, become familiar with the activity focusing on using it as an exemplar of strategically using broad and focused questions.
–   If you'd prefer to use a different activity, just be sure it provides ample opportunities to engage visitors in a discussion using broad and focused questions, a combination of IRE/IRF and reflective discourse types of conversations, and the Discussion Map.
–   Download a copy of the *Marine Skulls Cart* activity in the Resources section in cos-rop.net/cos.

4. Prepare the Jigsaw Research Cards, 1 set per group:
–   Research Card #1: The Value of Dialogue
–   Research Card #2: IRE (Initiate, Respond, Evaluate)
–   Research Card #3: Peer-to-Peer Discourse
–   Research Card #4: Value of Guidance in Learning Science
–   Research Card #5: Reflective Discourse and Monologues

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Session Details

Quick Write

1. Students do a Quick Write. Students write for five minutes on the following questions:
- What is it that makes conversations important for learning?
- Think about a time when you felt you were engaged in a learning conversation in a class or informal environment. What were the **characteristics of the conversation** that made you feel it was a real learning opportunity? (e.g., who was talking, what kinds of questions were used, and what kind of responses were elicited?)

2. Facilitate a whole group discussion. This discussion builds on participants' Quick Write responses with the goal of sharing ideas and identifying characteristics of conversations that support learning. Title two chart papers: ROLE OF CONVERSATIONS and CHARACTERISTICS OF CONVERSATIONS

3. What is the role of conversation in learning? Ask participants to share their responses to the first Quick Write question: What is the role of conversation in learning? In other words, why is talking important for learning?

4. Record their ideas. Record participants' ideas on the chart paper. The following is a list of comments that may arise.
- Arguments can be helpful to clarify ideas
- Opportunity to realize what I (the learner) don't know
- Organizes ideas about a topic
- Reiterates or rephrases information to make it understandable
- Opportunity to articulate first thoughts on a topic
- Opportunity to add ideas into the mix and build off of one another
- Mechanism to help remember what you know about a subject
- Helps participants create their own understanding of ideas
- Allows for disagreements and sharing of multiple viewpoints
- Opportunity to share in "safe" environment
- Provides opportunity for everyone to contribute and be included

5. What are the characteristics of a learning conversation? Ask participants to share their conversations with the whole group. Remember to ask participants to elaborate, clarify, and/or explain their comments.

6. Record their ideas. Record participants' ideas on the chart paper. The following is a list of comments that may arise.
- Participants have mutual interest in the topic
- Participants listen to each other
- Participants have opportunities to express their thoughts

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- Participants have opportunities to make inquiries
- All participants ask questions to seek information they do not know
- All participants provide information that identify, describe, or explain objects, ideas, or phenomena
- Participants generate explanations & produce justifications
- Participants are willing to see things in new ways
- Participants challenge current understandings
- Participants are open to views that conflict with their own
- Participants do not dismiss and routinely criticize other ideas

7. Make connections to previous discussions. As participants share their ideas, remind them to consider how specific ideas from the literature on *scaffolding*, *externalization and articulation*, and *reflection* (discussed in *Session 3: How Learning Happens*) occur in facilitated learning conversations.

Remember the following:
- Listen to their responses
- Ask participants to provide explanations, evidence, or clarifications to elaborate on their thinking. Suggested probing questions:
  - What makes you think that?
  - Please give an example from your experience.
  - What do you mean?
- Invite others to react and respond to the ideas shared. Suggested probing questions:
  - Can anyone add something to that comment?
  - Who would like to share an alternative opinion?
  - Does anyone disagree with that comment?
- Reference and cross-reference their comments as you facilitate the discussion to encourage participants to think about and respond to one another's ideas.

Research Discussion: Talking and Learning

1. Introduce Jigsaw. Tell participants each small group will receive a few research cards. Each card features a piece of information research has found out about talking and learning. Each member of their group is responsible for carefully reading one of the cards. Then they will take turns explaining the information from their card to their small group and having a discussion about what the information means. Like a jigsaw puzzle, each member of the team is in charge of one of the "pieces."
- Research Card #1: The Value of Dialogue

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  – Research Card #2: IRE (Initiate, Respond, Evaluate)
  – Research Card #3: Peer-to-Peer Discourse
  – Research Card #4: Value of Guidance in Learning Science
  – Research Card #5: Educator Monologue and Reflective Discourse

2. Each member leads a brief discussion about one research card. After each group member shares the information from a research card, they should tell the group their thoughts about the card. They should also invite group members to discuss the topic on the card, including:

  – Anything they find confusing about it.
  – Questions or issues they have about the topic on the card.
  – How teaching might be structured to take this piece of information into account.

During this discussion, each member should hold onto, and be in charge of their research card. They should continue the sharing and discussing process until you tell them to stop.

3. Large group share. After about 15 minutes of discussion, ask each group to share out any issues, ideas, or questions that came up during their small group discussion.

4. Explaining rationale behind jigsaw activity. Tell participants that this type of jigsaw activity is meant to encourage collaboration and discussion in small groups. Having each member responsible for the information on their card, and leading the discussion about that information, can help keep everyone involved in the discussion, and prevents any one person from dominating the group.

> Remember the following:
> - Listen to their responses
> - Ask participants to provide explanations, evidence, or clarifications to elaborate on their thinking. Suggested probing questions:
>   - What makes you think that?
>   - Please give an example from your experience.
>   - What do you mean?
> - Invite others to react and respond to the ideas shared. Suggested probing questions:
>   - Can anyone add something to that comment?
>   - Who would like to share an alternative opinion?
>   - Does anyone disagree with that comment?
> - Reference and cross-reference their comments as you facilitate the discussion to encourage participants to think about and respond to one another's ideas.

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Activity: Role-plays. 45 minutes

Introduce the Activity
1. Introduce the role-plays. Let participants know that in this next activity they will observe (or participate in) three role-plays. These role-plays simulate facilitated conversations in informal science education institutions.

2. Focus on the questions in the conversation. Their task is to pay attention to the *talk* that takes place between the educator and learners. We will focus on the questions:
  – Who is asking the questions?
  – What are the questions prompting from the other person(s)?
  – What is the "pattern" in the conversation?

3. Draw three columns. Draw three columns on the board, one for each role-play. Record "who is asking questions" and "what is the question prompting" during the debrief of each role-play in each column.

Role-play 1: Educator Monologue
1. Ask for volunteers for first role-play. Ask for three volunteers to be in the first role-play. Distribute a highlighted script to each volunteer and instruct him or her to read his or her highlighted lines when appropriate.

2. Distribute first Role-Play Script Worksheet to all participants. Distribute the *Role-Play Script Worksheet* for Role-Play Skit #1 to participants. Explain that they will use this worksheet to take notes as they observe the skit and actors in action. The worksheet includes the entire script so they can follow along. There is a column titled "Educator" and one titled "Learner." They should record observation data for each speaker accordingly. Examples of observation data include: question, information, praise, or instruction.

3. Volunteers engage in the role-play. Remind the volunteers to read what is written in the script, and do not adlib. The role-plays are not a reflection of anyone's teaching practice, but are created to demonstrate specific ideas for our discussion in this session.

4. Display the *Role-Play Debrief Chart*. Tell participants you will record their ideas about each role-play here.

5. Debrief first role-play. Use the following prompts as a guide to discuss the conversation and use of questions in the first skit. Ask groups to share their observations and explanations, encourage them to comment on each other's explanations, and remind them to provide evidence for the comments as you debrief the role-play. Record the patterns they identify on the board so everyone can see them.

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- How would you describe the interaction between the educator and the visitors in the skit?
  - What about what the educator said or did makes you think that?
  - Does anybody have a different idea or viewpoint?
- Who was asking the questions?
  - How would you describe the questions being asked?
- What were the questions prompting from the other person(s)?
  - Was this different depending on the speaker?
- What was the "pattern" in the conversation?
  - What makes you think that?
  - Does anyone have a different idea or viewpoint?
- How do you think the educator saw his/her role as an educator?
- If this educator was asked why she/he used questions in her/his interactions with visitors, what do you think they would say?

CAUTION. As participants begin discussing the talk in the role-plays, be careful that the discussion does not focus on placing judgment and value on one skit over the other, or that any one is "good" or "bad." The focus should be on recognizing the questions and what the educator is doing with the questions.

Key ideas to address
- This role-play features an <u>Educator Monologue</u> pattern.
  - The turn-taking may or may not alternate between educator and learner.
  - The educator's turn to talk is usually longer than the learner's.
  - The educator or learner initiates a question or comment, and the educator responds with a long narrative, explanation, or summary of ideas.
- There are open- and close-ended questions asking learner to provide information about what they know.
  - The educator and learners both ask questions.
- The kinds of information provided are identification and descriptions of what is observed and experienced, and explanations of scientific knowledge, typically disseminated in textbooks and other reference materials.
  - The educator provides most of the information.

Role-play 2: Initiate-Respond-Evaluate/ Initiate-Respond-Follow-up (IRE/IRF)
1. Ask for volunteers for second role-play. Ask for three volunteers to be in the second role-play. Distribute a highlighted script to each volunteer

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and instruct him or her to read his or her highlighted lines when appropriate.

2. Distribute second Role-Play Script Worksheet to all participants.
Distribute the *Role-Play Script Worksheet* for Role-Play Skit #2 to students.

3. Volunteers engage in the role-play. Remind the volunteers to read what is written in the script, and do not adlib. The role-plays are not a reflection of anyone's teaching practice, but are created to demonstrate specific ideas for our discussion in this session.

4. Debrief second role-play. Use the following prompts as a guide to discuss the conversation and use of questions in the second skit. Ask groups to share their observations and explanations, encourage them to comment on each other's explanations, and remind them to provide evidence for the comments as you debrief the role-play. Record the patterns they identify on the board so everyone can see them.

- How would you describe the interaction between the educator and the visitors in the skit?
    - What about what the educator said or did makes you think that?
    - Does anybody have a different idea or viewpoint?
- Who was asking the questions?
    - How would you describe the questions being asked?
- What were the questions prompting from the other person(s)?
    - Was this different depending on the speaker?
- What was the "pattern" in the conversation?
    - What makes you think that?
    - Does anyone have a different idea or viewpoint?
- How do you think the educator saw his/her role as a educator?
- If this educator was asked why she/he used questions in her/his interactions with visitors, what do you think they would say?
    - How does what the educator do in this skit differ from the previous skit?

CAUTION. As participants begin discussing the talk in the role-plays, be careful that the discussion does not focus on placing judgment and value on one skit over the other, or that any one is "good" or "bad." The focus should be on recognizing the questions and what the educator is doing with the questions.

Key ideas to address

- This role-play features an IRE/IRF (initiate, respond, evaluate/initiate, respond, follow up) pattern.
    - The turn taking switches back and forth between educator and learner regularly.

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- o The educator's turn to talk may or may not be longer than the learner's.
  - o The educator *initiates* the conversation with a question or comment, the learner *responds*, the educator *evaluates* the response and then provides an elaboration to the learner's response (or *follows up* with a question or statement to probe learner for more information). The pattern repeats with another educator initiated question or comment.
- – There are mostly close-ended questions and some open-ended questions; these questions ask learners to identify and describe what they see, and tell what they know.
  - o The educator asks questions s/he knows the answer to, and determines the correctness of the response.
  - o Learner's responses may be short answers.
  - o Educator's evaluation may be long and elaborate on the learner's response.
- – The kinds of information provided are identification and descriptions of what is observed and experienced, and explanations of scientific knowledge, typically disseminated in textbooks and other reference materials.
  - o The learners mostly identify and describe what they see.
  - o The educator mostly acknowledges the accuracy of the information.
  - o The educator explains the idea with scientific concepts.

Role-play 3: Reflective Discourse
1. Ask for volunteers for third role-play. Ask for three volunteers to be in the third role-play. Distribute a highlighted script to each volunteer and instruct him or her to read his or her highlighted lines when appropriate.

2. Distribute third Role-Play Script Worksheet to all participants.
Distribute the *Role-Play Script Worksheet* for Role-Play Skit #3 to students.

3. Volunteers engage in the role-play. Remind the volunteers to read what is written in the script, and do not adlib. The role-plays are not a reflection of anyone's teaching practice, but are created to demonstrate specific ideas for our discussion in this session.

2. Debrief third role-play. Use the following prompts as a guide to discuss the pattern of talk. Ask groups to share their observations and explanations, encourage them to comment on each other's explanations, and remind them to provide evidence for the comments as you debrief the role-play. Record the patterns they identify on the board so everyone can see them.
- – How would you describe the interaction between the educator and the visitors in the skit?

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- o What about what the educator said or did makes you think that?
- o Does anybody have a different idea or viewpoint?
- – Who was asking the questions?
  - o How would you describe the questions being asked?
- – What were the questions prompting from the other person(s)?
  - o Was this different depending on the speaker?
- – What was the "pattern" in the conversation?
  - o What makes you think that?
  - o Does anyone have a different idea or viewpoint?
- – How do you think the educator saw his/her role as an educator?
- – If this educator was asked why she/he used questions in her/his interactions with visitors, what do you think they would say?
  - o How does what the educator do in this skit differ from the previous two?

CAUTION. As participants begin discussing the talk in the role-plays, be careful that the discussion does not focus on placing judgment and value on one skit over the other, or that any one is "good" or "bad." The focus should be on recognizing the questions and what the educator is doing with the questions.

Key ideas to address

- – This role-play features a Reflective Discourse pattern.
  - o The turn taking switches back and forth between educator and learner.
  - o Educator and learner initiate, respond to, and follow up on each other's comments.
  - o If there is more than one learner, they are talking with each other and trying to understand each other's thinking.
- – There are mostly open-ended questions asking learners to explain and elaborate on what they think, and respond to what others say.
  - o Educator and learner are asking questions.
  - o Educator and learner are answering questions.
- – The kinds of information provided are identification and descriptions of what is observed and experienced, and explanations of what educator and learners think to be possible explanations.
  - o Educator responses to learner comments are neutral, i.e., educator does not evaluate responses, but instead asks for additional viewpoints and probes learners to elaborate on their thinking with evidence, explanation, and clarification.
  - o Learner elaborates on his or her thinking.
  - o Learner provides or considers multiple viewpoints.

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Debrief patterns of conversations

1. Learning is making connections. Remind students that

– Learning is *an active process* of engaging and manipulating objects, experiences, and conversations in order to construct understanding of the world (Dewey, 1938; Piaget, 1964; Vygotsky, 1986).

– Learning *builds on prior knowledge*, and involves enriching, building on, and changing existing understanding (Alexander, 1996, p. 89).

2. These skits are exaggerations of facilitated conversations. Let students know that the scripts for the skits are modeled after patterns in the facilitated conversations in classrooms as well as interactions in informal science education institutions. Most educator-led conversations are typically Educator Monologue and IRE/IRF. However, it is also important to keep in mind that the educator may move between patterns.

> For instance, an educator may begin with Reflective Discourse to give learners a chance to express their everyday views in order to motivate and encourage learners to be engaged, to legitimize learners' ways of thinking, and to probe learners' prior knowledge. The educator may shift to IRF to draw out more of learners' thinking and guide the expressions of their understanding toward the scientific views. The educator may transition into Monologue to model how to voice and connect learners' everyday ideas in scientific language, and then finish with more Reflective Discourse to give learners the opportunity to practice using scientific language.

3. Remember that the opportunity to express ones' ideas and explain ones' reasoning is critical for learning and long-term memory. Summarize for students that the important idea to understand and keep in mind is that the opportunity for learners to: (1) express what they think, (2) explain the reasoning underlying that thinking, and (3) make connections between their ideas *verbally* with peers and experts is important for learning.

> A recent study (van Blankenstein et al., 2011) of 70 undergraduate students working in small group found that active engagement in explaining their thinking verbally with peers during discussions positively affected long-term memory.

Thus, if we accept that learners *need* to discuss and connect ideas in order to construct understanding of science in a meaningful way, then we must provide opportunities for this type of discussion to occur. So how do we do it?

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Research Discussion: Asking questions, Facilitating discussions

Questions in conversations
1. Display *What research says about "Questions."* Display the following statements. Have students read and discuss with a partner what they think of these ideas.

- True dialogue occurs when teachers ask questions to which they do not presume to already know the correct answer (Lemke 1990, p. 55).
- The opportunity to generate questions places the learner in an active, initiating role in the learning process (Palinscar & Brown, 1984), and situates them as producers of knowledge, not just consumers.
- Seventy-five percent of the questions teachers ask are of a factual or literal nature (Bromley 1992:139).

2. Share what they discussed. Ask students to share with the group what they discussed. Take several responses and encourage a dialogue among participants.

3. Revisiting the skits. Ask students to take a closer look at the questions in the skits. Use the following prompts to initiate the discussion:
- How would you categorize the questions asked in the skits?
- What did you notice was the effect of the types of questions?

4. Types of questions. Let participants know that, generally speaking, questions are a very important part of learning conversations. They can be grouped into two categories: broad and focused. Emphasize that each type generates different kinds of responses, but neither type of question should be considered "good" or "bad." It is important for the educator to be able to recognize these types of questions and think strategically and purposefully about the questions they ask.

5. Broad and focused questions. Display the slide "types of questions" and explain broad and focused questions. Provide some examples.
- Focused questions ask for a specific answer, usually a short response.
  - Can you see it?
  - Do you want to touch it?
  - Do you think it's an animal?
  - What's that part called?
  - How many arms do you see?
  - What is that?
- Broad questions ask for a range of answers, usually an extensive response.
  - What's your theory so far?

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- o What do you think?
- o Why did they make it like that?
- o What does it look like to you?
- o Tell me more about your idea.

6. Small group discussion. Ask participants to discuss in their table groups the following questions:
- What do each type of question prompt from the other person(s) in the conversation?
- What are the advantages and disadvantages of each type of questions?
- Provide examples for when in teaching it would be effective to use each type of question.

7. Whole group discussion. Invite participants to share their discussions. Use the Discussion Map as a suggested guide to facilitate this discussion.

Discussion Map:
- Ask a broad question
- Listen to their responses
- Ask participants to provide explanations, evidence, or clarifications to elaborate on their thinking. Suggested probing questions:
  - o What makes you think that?
  - o Please give an example from your experience.
  - o What do you mean?
- Invite others to react and respond to the ideas shared. Suggested probing questions:
  - o Can anyone add something to that comment?
  - o Who would like to share an alternative opinion?
  - o Does anyone disagree with that comment?
- Reference and cross-reference their comments as you facilitate the discussion to encourage participants to think about and respond to one another's ideas.

Key points to address:
Focused questions
- Require learners to recall specific information
- Focus learners' responses on the topic specified by the educator.
- Keep the interchange short and to the point
- In general, focused questions are not good for starting discussions. A common mistake educators make is to begin a discussion by asking a focused question and, when learners don't readily respond, trying to reword

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the same question and give hints about the specific response they expect.

Broad questions
- Encourage learners to interact with the materials
- Open up the discussion for more viewpoints and contributions from learners
- Encourage divergent thinking
- In general, broad questions are not good to wrap-up a discussion, or if the educator is looking for a specific answer.

8. Focused questions are not necessarily easier to answer. In thinking about educators' use of so many focused questions, we should consider how an educator's perspective could influence the choice of questions. A focused question may appear simpler and safer for learners to answer than a broad question—so they may think they are making it easier for learners to respond. The problem with this premise is that learners may a) have differing understandings of the specific kinds of factual knowledge and details being asked about; or 2) they may be very concerned about providing an incorrect answer and being told they are wrong in front of others. In either case, these learners may be unwilling to take a chance and therefore, focused questions can be more difficult and unnerving for these students.

Also, common mistake made by educators is to attempt to begin a discussion by asking a focused question. When learners do not readily respond, the educator may then reword the initial question and provide hints about the specific response they expect. This clearly communicates to learners that there are "wrong" ways of participating in the discussion and may discourage those who are not so certain about the answer from joining in.

9. Educators may not feel comfortable with open discourse. Educators may avoid using more broad questions for many reasons.
- They might worry about fielding learner responses that may be inaccurate or unpredictable.
- They might have limited time to communicate a large amount of information and may be concerned that the discussion may range away from the main topic they seek to teach.
- They might be concerned that open-ended discourse may lead to topics they do not have deep understanding of or experience with.

10. Being purposeful about asking questions. Summarize for students that the important idea to remember is to be purposeful about the questions they ask in the first place. Educators may ask questions to:
- Stimulate learners' thinking
- Generate feedback for them about learners' understanding

  – Evaluate what learners know
  – Elicit what learners think and encourage learners to extend their ideas
  – Scaffold learner thinking as they help learners build knowledge

Introduce the Discussion Map

1. Introduce map. Tell students that asking thought-provoking, purposeful questions, which includes giving learners the opportunity to ask questions, is only one part of learning conversations. Researchers have studied effective strategies for facilitating discussions, and have developed the idea of a "discussion map" to reflect how skilled discussion leaders tend to guide and encourage discourse. This map can be applied to discussions with any age group.

2. Display discussion map. Project the *Discussion Map* and read each step aloud:

  – Ask a broad question
  – Listen to responses and thinking
  – Challenge learners to provide evidence or explanations
  – Encourage alternative opinions or ideas
  – Connect back to the main topic
  – Help to organize and summarize the ideas

3. Point out importance of listening carefully after each response and following learners' thinking. Explain that these steps represent a useful *sequence* to facilitate a conversation, but they don't specify exactly what the educator says. It is necessary to listen carefully to each learner's response and encourage them to articulate their ideas in full. The purpose is to allow learners to express themselves, make connections between their ideas, and challenge them to organize and reconsider their thinking in relation to what they and others say. The most important factor in facilitating discussions is following (and guiding) the natural flow of the exchange of ideas.

4. Staying neutral is important. Tell students that it is important to be non-judgmental in their responses. Keep a "poker face," and refrain from saying "right!" to the response they expect and hope to hear. Their neutrality encourages learners to contribute the learners' viewpoints, which is critical for constructing meaning. So let students know to take their time, be sure to pause after questions and comments, and encourage their learners to explain their reasoning.

4. Relate discussion map to skit discussions. Explain that the discussions you just led with them about the skits were structured using this map. Display the Discussion Map Example and review how they follow the discussion map.

  Ask a broad question:

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– How would you describe the interaction between the educator and the visitors in the first skit?

Listen to response and thinking.

Challenge learners to provide evidence or explanation.
– What about what the educator said or did makes you think that?
– Please explain what you mean.
– What is your evidence for that comment?

Encourage alternative opinions or ideas.
– Does anybody have a different idea or viewpoint?
– Does everyone agree?

Connect back to the main topic.
– How do you think the educator saw his/her role as a educator?
– If this educator was asked why she/he used questions in her/his interactions with visitors, what do you think they would say?

5. Discussion Map modeled throughout course. Point out that the discussions in previous course sessions were also facilitated using this map as a guide. This Discussion Map model is well-suited for an educator who seeks to facilitate learners in constructing their own conceptual understanding. It allows:
– Diverse ideas to emerge
– Learners to compare evidence for varying points of view
– Learners to articulate what they are thinking and why they think it

6. Describe flexible use of Discussion Map. The Discussion Map idea is very useful, but it's not intended to be a full description of discussion-leading strategies. It works best when used as a flexible model to guide discussions, rather than a rote procedure to be followed step-by-step. Often each step can involve multiple learner responses, and learner-to-learner responses, without the teacher intervening between each response.

Note to Instructor. There are two choices of activities that can be used to illustrate the pedagogy presented in this session. Decide which of these (or something else of your choice) seems to be most appropriate and interesting for your participants to engage in. The two choices are: a science briefing on Deep Sea/Adaptations, or the COSIA Skull Cart activity. (See below).

Science Briefing: Deep Sea/Adaptation or other science concept

Adaptation Interactive Science Briefing Presentation
Participants learn about adaptation and evolution as they participate in an interactive presentation highlighting questioning strategies, the Discussion Map, and the interplay between different kinds of

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conversations (monologue, IRE/IRF, and reflective discourse). (See index of Science Briefings Presentations on the web site if you're interested in obtaining the PowerPoint for this presentation.)

Introduce the science briefing.
1. Model the Discussion Map. Tell students that the instructors will model the use of the Discussion Map in a different instructional context – large-class lecture. As they participate in the *Science Briefing*, they should be thoughtful about how the Discussion Map is used.

Activity: Skull Cart

Introduce the activity.
1. Students engage in activity. Have an experienced educator lead the COSIA Skull Cart activity as students participate and/or observe visitor interactions. As students participate in the Skull Cart, they should watch specifically for the educator's use of questions, the Discussion Map, and the interplay between the kinds of conversations.

Think-Pair-Share: Adding Key Characteristics (Optional)

Note to Instructor. If you're continuing to add to the "Key Characteristics of Exemplar Activities & Facilitation" chart begun in Session 5: Designing an Activity, give students the opportunity to add/modify items on the list.

1. Reflecting on and applying ideas. Ask students to think about how to apply these additional ideas on supporting learning in the design of their activities. Have students do a Think-Pair-Share to generate new or modify existing items on the *"Key Characteristics of Exemplar Activities & Facilitation"* that the class developed in the previous session. Display the following prompts:
  – How have your ideas changed?
  – What do you think made your ideas change?
  – **How might you use this in your science teaching?**

Potential new items:

  – Encourages questions and follows the interests of the visitors
  – Is sensitive to the visitors' prior ideas and knowledge about this topic
  – Encourages and provides opportunities for discussion/discourse and other social interactions between visitors or family/group members
  – Includes opportunities for visitors to make meaning individually, with peers and with someone more knowledgeable (e.g. facilitator/knowledgeable visitor)

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– Includes opportunities to engage with and manipulate objects, experiences and conversations in a social setting

2. Display the *Key Characteristics of Exemplar Activities & Facilitation.* Display the *Key Characteristics* that the class generated in the previous session. Distribute a pad of sticky-notes to each pair. Ask each pair of students to come up with one item to modify or add to the list. They should write their item on the sticky note and post it on the list.

Homework

Reading:
– Fenichel, M. & Schweingruber, H.A. (2009). *Surrounded by Science: Learning Science in Informal Environments*. National Academies Press: Washington, D.C.
    o Ch 5, Interest and Motivation: Steps toward Building a Science Identity, pg 81-102.
– Castro, P & Huber, M.E. (2008). *Marine Biology*, 8th ed. McGraw-Hill Higher Education.
    o Ch14, Coral Reefs, p. 307-331.

Task:
– Activity Design Starter & Science Content papers next session.
– Midterm exam next session.

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Research Card #1:

The Value of Conversations

Human thinking is shaped by the social activities and use of the materials and symbols invented by culture, which in turn are temporally and geographically influenced (Schauble, et al., 1997, p. 4). Vygotsky (1978) further detailed the importance of discourse by arguing that higher mental functions have social origins that are first expressed between individuals before they are internalized within the individual. In other words, meanings are rehearsed and made explicit as a result of conversations and interactions between people before becoming internalized by the individual. In the sociocultural viewpoint, learning relies on conversation. For learners, engaging in conversations can foster more generative thinking and enable them to practice dialogic skills, such as asking questions and communicating ideas in an effective manner. It can be a way for them to process information and make social connections. These thinking and dialogic skills form the basis of active, analytic, individual thought, and allow individuals to develop their ability to communicate their ideas. For educators, talk from learners offers a glimpse into what learners think and how they make sense of new experiences in light of what they already know (Scott, 1998).

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Research Card #2:

Facilitating conversation: IRE Pattern

In what Mehan (1979) calls an IRE pattern, the educator *initiates* the conversation with a question or comment, the learner *responds*, the educator *evaluates* the response, then repeats the pattern with another question.

IRE example:
Educator: Is this a solid, liquid, or gas? (Initiate)
Learner: It's a liquid. (Respond)
Educator: Yes, it is a liquid. It takes the shape of its container. (Evaluate)
Educator: What about this one, is it a solid, liquid, or gas. (Initiate)
Learner: It's a liquid too. (Respond)
Educator: No, this one is a solid. (Evaluate)

The turn-taking switches back and forth regularly between educator and learner although the educator is directing the conversation because they are asking the questions and determining the correctness of the response. Also, the learner's response may be short answers, while the educator's evaluation may be long, and may elaborate on the learner's response. The educator controls the conversation by the topics they allow to be formulated and the "off-topics" they ignore (Eder, 1982).

A variation to IRE is IRF. In this case, the educator *initiates* the conversation with a question or comment, the learner *responds*, and the educator solicits a *follow up* response from the learner for further ideas and clarifications. The turn-taking switches back and forth regularly between educator and learner, although the educator is directing the conversation because they are asking the questions and soliciting follow up responses.

IRF example:
Educator: Is this a solid, liquid, or gas? (Initiate)
Learner: It's a solid (Respond)
Educator: What makes you say that it's a solid? (Follow-up)
Learner: Because it holds its shape. (Respond)
Educator: You're right, it is a solid. (Evaluate)

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Research Card #3:

Peer-to-Peer Discourse

Peer talk unfolds in pairs or groups of children unhindered by the inherent asymmetry of adult–child interaction. The more equal participant structure of peer groups may be conducive to both cognitive and pragmatic development. Rogoff (1990) highlights Piaget's (1977) argument that children's discussions with adults are less conducive to cognitive development than their discussions with equals—while the superiority of adults might intimidate children from freely expressing their ideas, other children can provide the opportunity for discussion and reciprocal exchanges, thus promoting the types of social interaction conducive to cognitive development. Opportunities to talk are important for learners to share, clarify, and distribute knowledge among peers. Peer discussions exhibit the following characteristics: asking questions, hypothesizing, explaining, and formulating ideas. (Rivard & Straw, 2000)

Research Card #4:

Value of Guidance in Learning Science

Learning science adds increased complexity to the practice of facilitating discourse. Learning science involves acquiring the language and tools of science and the canonical ways of reasoning in science (Anderson, Holland, & Palinscar, 1997; Kuhn, 1962), and is not possible without guidance and assistance (Scott, et al., 2006). "Learning science, therefore, is seen to involve more than the individual making sense of his or her personal experiences but also being initiated into the 'ways of seeing' which have been established and found to be fruitful by the scientific community. Such 'ways of seeing' cannot be 'discovered' by the learner—and if a learner happens upon the consensual viewpoint of the scientific community he or she would be unaware of the status of the idea" (Driver, 1989, p. 482). Thus it is necessary for science teachers and informal science educators to engage learners in dialogue about their everyday views of phenomena, **and** introduce the science perspective (science content) (Scott, et al., 2006). A significant part of learning science is learning to talk science. Tools of talk used in science, such as questioning, explaining, predicting, reasoning, and evaluating, are strategies that may need to be learned and practiced (Dawes, 2004; Lemke, 1990).

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Research Card #5:

Facilitating conversation: Reflective Discourse Pattern

Educator facilitates a conversation where learners and educators pose questions, respond to one another's comments and questions, and learners seek to understand each other. In a Reflective Discourse pattern, the educator and the learner are talking back and forth, and both are initiating, responding, and following up on each other's comments. The learner is expressing his or her own thoughts, ideas, and questions. If there is more than one learner, they are also talking with each other and trying to understand the thinking of another. The educator and learner engage in an exchange, asking and answering one another's questions, and trying to understand the thinking of the other person (van Zee & Minstrell, 1997). It offers learners the opportunity to voice their everyday views of the world in common language, but requires assistance and guidance from more knowledgeable individuals to make connections between everyday and scientific views (Scott, et al., 2006).

Facilitating conversation: Educator Monologue Pattern

Educator explains, describes, clarifies, identifies, and questions. In a Monologue, the educator is doing most of the talking, although whose turn it is to talk may alternate between educator and learner. The educator's turn is usually longer than the learner's, and the educator ends up doing most of the explaining, describing, clarifying, identifying, and questioning. The educator dominates the conversation with scientific views and explanations. It is perceived as an efficient way of communicating scientific knowledge, although it is criticized for expressing only one viewpoint and not allowing learners to articulate their understanding of the ideas.

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Role-Play Scripts

Educator-Visitor Skit #1

Scene: *In the exhibit space of an informal science education institution, an educator is standing behind a cart with a sea otter pelt displayed. Two visitors walk by; they approach the cart.*

Visitor #1: What is that?
Educator: It's a sea otter pelt. It's the skin and fur from a sea otter. Want to feel it?
Visitors: [*Both visitors caress the pelt.*]
Educator: [*Feeling the pelt too.*] It's soft, isn't it?
Visitor #2: [*nods*] It's very soft.
Educator: I love the way it feels. It feels thick too, doesn't it?
Visitor #1: Yeah, it does.
Educator: [*Hands magnifiers to both visitors.*] Take a close look at the fur.
Visitors: [*Visitors look closely at the pelt.*]
Visitor #1: This fur is thick!
Educator: Can you tell how many hairs there are in there?
Visitor #2: There are tons of hairs in there.
Visitor #1: Yeah.
Educator: This cardboard square is one square centimeter in size *shows cardboard square*. Someone once estimated that there are more than 155,000 hairs per square centimeter on a sea otter. Sea otters have more hairs in one square centimeter than people have on their whole head.
Educator: Why do sea otters have such thick fur?
Visitor #2: Maybe it's because they come out on land at night and get real cold.
Educator: It does feel cold when you get out of the water, doesn't it? Sea otters used to come out on land a lot, but now they hardly ever do. They spend almost all their time in the water, day and night. They live off the coast of northern California and in Alaska, and the water is very cold in both of those places. I've never heard of sea otters living in places with really warm water. Have you?
Visitor #1: No.
Educator: Thick fur is a structure that sea otters have that is an adaptation to survive in cold water. An adaptation is a structure or behavior that helps an organism survive. Their thick fur traps lots of air next to their skin. The air insulates their skin from the cold water. But that's not the only adaptation they have. Another adaptation they have is a behavior. They eat a lot of food. If you ever get to watch real sea otters-and I hope you do, cause they are so cool-you'll notice that they are constantly diving for food and eating the food they catch. Have you ever seen a real live sea otter?
Visitor #2: No, but I did see one on the nature channel and I want to see the sea otters here in the aquarium too.
Educator: The sea otters are inside this gallery and they are very cool. Did you know they have to eat about one quarter of their weight every day? That's like if an average 10 year old ate about 40 - 50 sandwiches every day. Have you ever known someone who is always eating and eating, but they don't gain weight? That's what sea otters are like. They're eating all the time but they burn off the calories in the cold water.

Visitor #2: Dang!
Educator: Do you know why they would have to eat so much?
Visitor #2: I guess they're really hungry? Are they like…really fat?
Educator: Here's a picture of one. [*Educator shows photo of sea otter to visitor.*] They only grow to be about the size of a large dog, which is small compared to other mammals that live in the ocean.
Visitor#2: Why would they have to eat more living in cold water?
Educator: Why do you think they'd need to eat more?
Visitor#2: When I'm cold I get really hungry. They probably get really hungry being in cold water all the time.
Visitor#1: Yeah, and it probably makes them hungry if they're swimming around all the time.
Educator: Well a whale, which is very big, has a low surface to volume ratio, right? A shrew, which is tiny, has a high surface to volume ratio, so it has to run around all the time so it can stay warm. And as far as marine mammals go, sea otters are small. And since sea otters are relatively small, they have a higher surface to volume ratio. So that's why they have to eat a lot of food.
Visitor #1: Really? Cool.
Visitor #2: [*speaking to visitor #1*] Let's go check out the sea otters.
Educator: Okay. Come back after you check them out, and I'll tell you more about them.
Visitor #1: OK, we'll try.

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Role-Play Scripts

Educator-Visitor Skit #2

Scene: *In the exhibit space of an informal science education institution, an educator is standing behind a cart with a sea otter pelt displayed. Two visitors walk by; the educator engages with them.*

Educator: Do you know what this is?
Visitor #2: Fur from a bear?
Educator: Well, it's from a marine mammal.
Visitor #1: Is it from a walrus?
Educator: You're getting closer. Look at the size.
Visitor #2: It's so small, maybe it's a sea otter.
Educator: That's right, it's a sea otter pelt. Sea otters have 155,000 hairs per square centimeter. That's more hairs in one square centimeter than people have on their whole head. Take a look. [*Hands lens to visitor #1.*]
Visitor #1: Yeah, that's really thick!
Educator: Yes, sea otters have really thick fur. Why do sea otters have such thick fur?
Visitor #2: To keep them warm?
Educator: Well it does help to keep them warm in some way, but think about your hair when it gets wet – does that help to keep you warm when you go swimming?
Visitor: No, not really. Maybe the thick fur is for when they come out on land at night and get real cold.
Educator: Most sea otters don't come onto land. They live in cold water in California and Alaska.
Visitor #2: So, how do they keep warm in the ocean?
Educator: The thick fur helps them stay warm because they put air into their fur and the thick fur traps it and creates an insulation layer that keeps them warm. What else do you think they do to stay warm?
Visitor #1: Do they wrap themselves up in kelp to stay warm?
Educator: Well that's how they keep their babies from floating away. To stay warm sea otters have to eat a lot of… [*waits for visitor to fill in the word*]
Visitor #1: Food.
Educator: That's right. They eat a lot of food to stay warm. Why do they have to eat more if they live in cold water?
Visitor #2: Maybe it has something to do with them being so small?
Educator: That's right. As far as marine mammals go, sea otters aren't big. And since sea otters are relatively small, they have a hard time staying warm in cold water even though they have such thick fur. So they have to eat a lot of food to get more energy to stay warm. Got it?
Visitor #1: Yeah.
Educator: In fact, they have to eat about one quarter of their weight every day. That's like if a person weighed 100 pounds, and they ate how much food per day?
Visitor #1: I don't know.
Visitor #2: 25 pounds.
Educator: That's right. That's a lot of food to have to eat every day. They live where

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the water is cold, so that's why they have all these adaptations.
Visitor #1: OK.
Educator: Another thing to know about sea otters is that they almost went extinct. Do you know why?
Visitor #2: Ummm, no.
Educator: It's because sea otters have such thick fur and people wanted the nice thick fur, so they hunted sea otters almost to extinction.
Visitor #2: Wow.
Educator: Go take a look at the sea otters in the gallery. If you have more questions about sea otters, come and ask me.
Visitor #1: OK. Thanks.

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Role-Play Scripts

Educator-Visitor Skit #3

Scene: *In the exhibit space of an informal science education institution, an educator is standing behind a cart with a sea otter pelt displayed. Two visitors walk by; they approach the cart.*

Visitor #1: What is that?
Educator: Come over closer and check it out. Go ahead and touch it if you want. Have you ever seen anything like this before?
Visitors: [*Both visitors caress the pelt.*]
Visitor #1: It kind of feels like my cat.
Educator: [*Asks Visitor #2*] What do *you* notice about this?
Visitor #2: It is really soft and thick – way softer than my cat and it has a long tail.
Educator: It does feel really soft and thick to me too. This is the skin and fur of a sea otter – it's called a pelt.
Visitor #1: Oh, yeah. I've heard of sea otters.
Educator: What have you heard about them?
Visitor #1: That they live in the ocean and they use tools.
Visitor #2: I've heard that stuff too. I think they use rocks on their tummy to help them eat. And they live near here, don't they?
Visitors: [*Pause*]
Visitor #1: Yeah I think they do.
Educator: Have you ever seen them in the wild?
Visitor #2: No, but I'd like to.
Educator: There are some that live near here in the ocean, not just in the aquarium. I've seen some out in front of the aquarium – right over there. [*Points to where the visitors could try to see them later.*] Check it out when you go outside later. Did you get a chance to see them here in the aquarium? What did you notice?
Visitor #2: They are really cute, but it seems like they are really, really itchy.
Educator: What makes you think they are itchy?
Visitor #1: They were always scratching and rolling around.
Educator: I know what you mean and scientists have noticed that too. Scientists have figured out a bit about why the sea otters scratch themselves all the time. Hey, would you like to try to figure out the mystery of the itchy sea otters too?
Visitors #1 and #2: [*all together*] Sure.
Educator: OK, great. Let's try it. Here's a magnifying glass so you can take a closer look.
Visitor #1: Whoa! There are a lot of hairs packed together
Educator: I know. If you look at it really closely, you can see that it's made up of a bunch of smaller hairs.
Visitors: [*Visitor continues to look closely at the pelt.*]
Visitor #2: Yeah and it looks like there are different kinds of hairs.
Educator: Their fur is thicker than almost any other animal.
Visitor #1: I wonder why?
Visitor #2: To keep them warm, maybe.

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Educator: [*looking at visitor 1*] Do you agree?
Visitor #1: Yes. Lots of other animals have thick fur to keep warm too.
Educator: Have you been in the water near here?
Visitor #1: Yes, it's pretty cold.
Visitor #2: And they're out there in the water all the time.
Educator: One thing I can tell you about fur is that it doesn't work very well to keep an animal warm in water. Think about your hair when it gets wet – it loses the ability to keep you warm anymore. Same thing with a sea otter. So, here's the mystery - how do you think their thick fur helps to keep them warm? Remember the things you noticed before about the sea otters.
Visitor #2: When the otter was diving, I saw lots of air bubbles.
Visitor #1: …and remember the way it was always scratching.
Visitor #2: But how can scratching and air bubbles keep the otter warm?
Educator: Let's think about it together. When the otter scratches itself, it creates a layer of air next to its skin and the thick fur helps to keep the air in there. The layer of air keeps its skin nice and dry and warm even in the cold water.
Visitor #2: Hey could those air bubbles we saw coming off the sea otter come from the bubbles that are caught in between the skin and the hair?
Visitor #1: Ooh, I bet yeah. And I bet the sea otters have to scratch all the time because it looks like the air bubbles escape a lot.
Educator: Hm. Pretty good thinking. I think you may be on to something. Let's see what else we can figure out about sea otters. You mentioned earlier that they use rocks on their tummy to help them eat.
Visitor #1: I saw in a book once where an otter was using rocks on a clam or something.
Visitor #2: Yeah they would need to use something to get through that shell.
Educator: Let's take a look at the shells of some of things they eat. Do you think they would need rocks for all of them?
Visitor #2: Not this little mussel.
Visitor #1: Oh, but look at this. [Picks up abalone shell and shows it to #1 and Educator.] This one is really thick. They would definitely need a rock for this one.
Educator: Why don't you go take a look at the otters in the tank and see if you notice any behaviors that could give you some clues, like you did before. There are a few books over here that you could look through too. Be sure to come back and let me know if you find out anything interesting.
Visitor #1: OK.

Role-Play Script Worksheet

Educator-Visitor Skit #1

Scene: *In the exhibit space of an informal science education institution, an educator is standing behind a cart with a sea otter pelt displayed. Two visitors walk by; they approach the cart.*

LEARNER	EDUCATOR	COMMENT
1		**Visitor #1:** What is that?
2		**Educator:** It's a sea otter pelt. It's the skin and fur from a sea otter. Want to feel it?
3		**Visitors:** [*Both visitors caress the pelt.*]
4		**Educator:** [*Feeling the pelt too.*] It's soft, isn't it?
5		**Visitor #2:** [*nods*] It's very soft.
6		**Educator:** I love the way it feels. It feels thick too, doesn't it?
7		**Visitor #1:** Yeah, it does.
8		**Educator:** [*Hands magnifiers to both visitors.*] Take a close look at the fur.
9		**Visitors:** [*Visitors look closely at the pelt.*]
10		**Visitor #1:** This fur is thick!
11		**Educator:** Can you tell how many hairs there are in there?
12		**Visitor #2:** There are tons of hairs in there.
13		**Visitor #1:** Yeah.
14		**Educator:** This cardboard square is one square centimeter in size *shows cardboard square*. Someone once estimated that there are more than 155,000 hairs per square centimeter on a sea otter. Sea otters have more hairs in one square centimeter than people have on their whole head.
15		**Educator:** Why do sea otters have such thick fur?
16		**Visitor #2:** Maybe it's because they come out on land at night and get real cold.
17		**Educator:** It does feel cold when you get out of the water, doesn't it? Sea otters used to come out on land a lot, but now they hardly ever do. They spend almost all their time in the water, day and night. They live off the coast of northern California and in Alaska, and the water is very cold in both of those places. I've never heard of sea otters living in places with really warm water. Have you?
18		**Visitor #1:** No.
19		**Educator:** Thick fur is a structure that sea otters have that is an adaptation to survive in cold water. An adaptation is a structure or behavior that helps an organism survive. Their thick fur traps lots

		of air next to their skin. The air insulates their skin from the cold water. But that's not the only adaptation they have. Another adaptation they have is a behavior. They eat a lot of food. If you ever get to watch real sea otters-and I hope you do, cause they are so cool-you'll notice that they are constantly diving for food and eating the food they catch. Have you ever seen a real live sea otter?
20		**Visitor #2:** No, but I did see one on the nature channel and I want to see the sea otters here in the aquarium too.
21		**Educator:** The sea otters are inside this gallery and they are very cool. Did you know they have to eat about one quarter of their weight every day? That's like if an average 10 year old ate about 40 - 50 sandwiches every day. Have you ever known someone who is always eating and eating, but they don't gain weight? That's what sea otters are like. They're eating all the time but they burn off the calories in the cold water.
22		**Visitor #2:** Dang!
23		**Educator:** Do you know why they would have to eat so much?
24		**Visitor #2:** I guess they're really hungry? Are they like…really fat?
25		**Educator:** Here's a picture of one. [*Educator shows photo of sea otter to visitor.*] They only grow to be about the size of a large dog, which is small compared to other mammals that live in the ocean.
26		**Visitor#2:** Why would they have to eat more living in cold water?
27		**Educator:** Why do you think they'd need to eat more?
28		**Visitor#2:** When I'm cold I get really hungry. They probably get really hungry being in cold water all the time.
29		**Visitor#1:** Yeah, and it probably makes them hungry if they're swimming around all the time.
30		**Educator:** Well a whale, which is very big, has a low surface to volume ratio, right? A shrew, which is tiny, has a high surface to volume ratio, so it has to run around all the time so it can stay warm. And as far as marine mammals go, sea otters are small. And since sea otters are relatively small, they have a higher surface to volume ratio. So that's why they have to eat a lot of food.
31		**Visitor #1:** Really? Cool.
32		**Visitor #2:** [*speaking to visitor #1*] Let's go check out the sea otters.
33		**Educator:** Okay. Come back after you check them out, and I'll tell you more about them.
34		**Visitor #1:** OK, we'll try.

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Role-Play Script Worksheet

Educator-Visitor Skit #2

Scene: *In the exhibit space of an informal science education institution, an educator is standing behind a cart with a sea otter pelt displayed. Two visitors walk by; the educator engages with them.*

LEARNER	EDUCATOR	COMMENT
1		**Educator:** Do you know what this is?
2		**Visitor #2:** Fur from a bear?
3		**Educator:** Well, it's from a marine mammal.
4		**Visitor #1:** Is it from a walrus?
5		**Educator:** You're getting closer. Look at the size.
6		**Visitor #2:** It's so small, maybe it's a sea otter.
7		**Educator:** That's right, it's a sea otter pelt. Sea otters have 155,000 hairs per square centimeter. That's more hairs in one square centimeter than people have on their whole head. Take a look. [*Hands lens to visitor #1.*]
8		**Visitor #1:** Yeah, that's really thick!
9		**Educator:** Yes, sea otters have really thick fur. Why do sea otters have such thick fur?
10		**Visitor #2:** To keep them warm?
11		**Educator:** Well it does help to keep them warm in some way, but think about your hair when it gets wet – does that help to keep you warm when you go swimming?
12		**Visitor:** No, not really. Maybe the thick fur is for when they come out on land at night and get real cold.
13		**Educator:** Most sea otters don't come onto land. They live in cold water in California and Alaska.
14		**Visitor #2:** So, how do they keep warm in the ocean?
15		**Educator:** The thick fur helps them stay warm because they put air into their fur and the thick fur traps it and creates an insulation layer that keeps them warm. What else do you think they do to stay warm?
16		**Visitor #1:** Do they wrap themselves up in kelp to stay warm?
17		**Educator:** Well that's how they keep their babies from floating away. To stay warm sea otters have to eat a lot of… [*waits for visitor to fill in the word*]
18		**Visitor #1:** Food.
19		**Educator:** That's right. They eat a lot of food to stay warm. Why

		do they have to eat more if they live in cold water?
20		**Visitor #2:** Maybe it has something to do with them being so small?
21		**Educator:** That's right. As far as marine mammals go, sea otters aren't big. And since sea otters are relatively small, they have a hard time staying warm in cold water even though they have such thick fur. So they have to eat a lot of food to get more energy to stay warm. Got it?
22		**Visitor #1:** Yeah.
23		**Educator:** In fact, they have to eat about one quarter of their weight every day. That's like if a person weighed 100 pounds, and they ate how much food per day?
24		**Visitor #1:** I don't know.
25		**Visitor #2:** 25 pounds.
26		**Educator:** That's right. That's a lot of food to have to eat every day. They live where the water is cold, so that's why they have all these adaptations.
27		**Visitor #1:** OK.
28		**Educator:** Another thing to know about sea otters is that they almost went extinct. Do you know why?
29		**Visitor #2:** Ummm, no.
30		**Educator:** It's because sea otters have such thick fur and people wanted the nice thick fur, so they hunted sea otters almost to extinction.
31		**Visitor #2:** Wow.
32		**Educator:** Go take a look at the sea otters in the gallery. If you have more questions about sea otters, come and ask me.
33		**Visitor #1:** OK. Thanks.

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Role-Play Script Worksheet

Educator-Visitor Skit #3

Scene: In the exhibit space of an informal science education institution, an educator is standing behind a cart with a sea otter pelt displayed. Two visitors walk by; they approach the cart.

LEARNER	EDUCATOR	COMMENT
1		**Visitor #1:** What is that?
2		**Educator:** Come over closer and check it out. Go ahead and touch it if you want. Have you ever seen anything like this before?
3		**Visitors:** [*Both visitors caress the pelt.*]
4		**Visitor #1:** It kind of feels like my cat.
5		**Educator:** [*Asks Visitor #2*] What do *you* notice about this?
6		**Visitor #2:** It is really soft and thick – way softer than my cat and it has a long tail.
7		**Educator:** It does feel really soft and thick to me too. This is the skin and fur of a sea otter – it's called a pelt.
8		**Visitor #1:** Oh, yeah. I've heard of sea otters.
9		**Educator:** What have you heard about them?
10		**Visitor #1:** That they live in the ocean and they use tools.
11		**Visitor #2:** I've heard that stuff too. I think they use rocks on their tummy to help them eat. And they live near here, don't they?
12		**Visitors:** [*Pause*]
13		**Visitor #1:** Yeah I think they do.
14		**Educator:** Have you ever seen them in the wild?
15		**Visitor #2**: No, but I'd like to.
16		**Educator:** There are some that live near here in the ocean, not just in the aquarium. I've seen some out in front of the aquarium – right over there. [*Points to where the visitors could try to see them later.*] Check it out when you go outside later. Did you get a chance to see them here in the aquarium? What did you notice?
17		**Visitor #2**: They are really cute, but it seems like they are really, really itchy.
18		**Educator:** What makes you think they are itchy?
19		**Visitor #1:** They were always scratching and rolling around.
20		**Educator:** I know what you mean and scientists have noticed that too. Scientists have figured out a bit about why the sea otters scratch themselves all the time. Hey, would you like to try to figure out the mystery of the itchy sea otters too?
21		**Visitors #1 and #2**: [*all together*] Sure.
22		**Educator:** OK, great. Let's try it. Here's a magnifying glass so you can take a closer look.
23		**Visitor #1:** Whoa! There are a lot of hairs packed together
24		**Educator:** I know. If you look at it really closely, you can see that it's made up of a bunch of smaller hairs.
25		**Visitors:** [*Visitor continues to look closely at the pelt.*]
26		**Visitor #2:** Yeah and it looks like there are different kinds of hairs.

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27		**Educator:** Their fur is thicker than almost any other animal.
28		**Visitor #1:** I wonder why?
29		**Visitor #2:** To keep them warm, maybe.
30		**Educator:** [*looking at visitor 1*] Do you agree?
31		**Visitor #1:** Yes. Lots of other animals have thick fur to keep warm too.
32		**Educator:** Have you been in the water near here?
33		**Visitor #1:** Yes, it's pretty cold.
34		**Visitor #2:** And they're out there in the water all the time.
35		**Educator:** One thing I can tell you about fur is that it doesn't work very well to keep an animal warm in water. Think about your hair when it gets wet – it loses the ability to keep you warm anymore. Same thing with a sea otter. So, here's the mystery - how do you think their thick fur helps to keep them warm? Remember the things you noticed before about the sea otters.
36		**Visitor #2:** When the otter was diving, I saw lots of air bubbles.
37		**Visitor #1:** …and remember the way it was always scratching.
38		**Visitor #2:** But how can scratching and air bubbles keep the otter warm?
39		**Educator:** Let's think about it together. When the otter scratches itself, it creates a layer of air next to its skin and the thick fur helps to keep the air in there. The layer of air keeps its skin nice and dry and warm even in the cold water.
40		**Visitor #2:** Hey could those air bubbles we saw coming off the sea otter come from the bubbles that are caught in between the skin and the hair?
41		**Visitor #1:** Ooh, I bet yeah. And I bet the sea otters have to scratch all the time because it looks like the air bubbles escape a lot.
42		**Educator:** Hm. Pretty good thinking. I think you may be on to something. Let's see what else we can figure out about sea otters. You mentioned earlier that they use rocks on their tummy to help them eat.
43		**Visitor #1:** I saw in a book once where an otter was using rocks on a clam or something.
44		**Visitor #2:** Yeah they would need to use something to get through that shell.
45		**Educator:** Let's take a look at the shells of some of things they eat. Do you think they would need rocks for all of them?
46		**Visitor #2:** Not this little mussel.
47		**Visitor #1:** Oh, but look at this. [*Picks up abalone shell and shows it to #1 and Educator.*] This one is really thick. They would definitely need a rock for this one.
48		**Educator:** Why don't you go take a look at the otters in the tank and see if you notice any behaviors that could give you some clues, like you did before. There are a few books over here that you could look through too. Be sure to come back and let me know if you find out anything interesting.
49		**Visitor #1:** OK.

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Types of Questions Defined

Broad Question—A statement or question that anticipates a variety of acceptable and generally unpredictable responses.

When an educator asks such questions, they are hoping for unplanned, divergent outcomes. These questions require that the learners utilize thinking processes in ways that are unique to the individual rather than planned by the educator. Broad questions allow the learner to make sense of and explore their own ideas freely, in their own terms, without restrictions and with only minimal guidance by the educator. These questions are useful to encourage learners to synthesize ideas, extend ideas, deduce and predict, or organize elements of what they've learned into a fresh pattern. Broad questions encourage learners to share various ideas during a discussion and to value other learners' ideas as they are expressed.

Focused Question—A statement or question that anticipates a particular, predictable response planned by the educator.

A specific "correct" response or set of responses is anticipated when an educator asks a focused question. Focused questions can require the learner to remember information or recognize information that is readily at hand. This is useful to help learners recall a fact, define a term, identify something, or review a topic that has been learned. Focused questions can be used to confirm previous classroom experiences in order to help establish a base of information for new experiences. Focused questions can also help learners synthesize information in a particular way as guided by the educator. Focused questions that ask learners to integrate what they've previously learned are useful if you want them to compare, contrast, associate, explain, state relationships, or arrive at particular conclusions. "Compare," "tell," and "explain" can begin these kinds of integrating statements. Even though a predictable answer is asked for, learners may give an explanation in their own words.

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Discussion Map

An educator encouraging learners to construct their own conceptual understanding can use a structure for questioning that encourages discussion and helps to "unpack" their ideas.

– Ask a broad question
– Listen to responses and thinking
– Challenge learners to provide evidence or explanations
– Encourage alternative opinions or ideas
– Connect back to the main topic
– Help to organize and summarize the ideas

Listen carefully to each learner response and try to understand their thinking

Roles for Educators

Guide on the Side: Educators who see themselves as facilitators of learning, helping to direct individual learner discoveries and acting as co-collaborators while investigating topics together.

Sage on the Stage: Educators who see themselves as the primary bearers of information and understanding, as experts whose role is to fill learners' "blank slates" with correct information.

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Questions and the Learning Cycle

Consider the possible purposes for asking questions during different phases of learning.

Invitation Stage: Use questions to help generate interest, and help learners focus on observations. Help learners to connect past experience to a new topic of study.
– Have you ever seen...?
– Have you ever wondered…?
– What did you observe?
– Did you notice...?

Exploration Stage: Use questions to encourage learners to explore new materials, properties, and events. Guide learners to engage in productive investigations.
– What happened when...?
– What did you discover?
– What do you think will happen if...?
– What do you think made that happen?
– What questions do you have about…?
– What could we do to find out?

Concept Invention Stage: Use questions to help learners synthesize new understandings and make sense of investigations. Help learners classify, categorize, quantify, or order their observations. Have learners use evidence from investigations to make explanations. Help learners draw conclusions and make connections.
– What did you find out about...?
– How is this the same or different from..?
– Can you compare this to something else?
– What do you think is the explanation for…?
– Why do you think that...? What is your evidence?
– What might another explanation be?

Application Stage: Use broad questions to encourage reasoning and analysis. Involve learners in authentic problem-solving situations and critical thinking. Help learners generalize their knowledge and test their hypotheses. Encourage learners to apply new learning to other situations.
– What do you now know about the characteristics of...?
– What other factors do you think might be involved?
– Can you find a way to...?
– How can we use what we found out to solve a problem?
– How could you be more sure about…?

Reflection Stage: Use questions to encourage learners to think back on what they have done and how they have made sense of what they have explored.
– How did you arrive at your solution or conclusion?
– Did you change any of your initial thinking?
– What caused you to see things differently?
– How did you figure out…?

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