Session 7: Objects & Engagement

Overview

This session is one of four *Apply and Refine* sessions, which can be done in any order. In this session, students examine the use of objects in learning experiences in informal environments, and think about the role of the objects in conversations and interactions. Students explore how different types of objects that are commonly found in informal environments can be used to support learning. They are challenged to use the "*Characteristics of Exemplar Activities and Facilitation*" they have been developing in class, and then create and implement an activity or program to teach one idea using four types of objects. This activity provides them with a common experience to think about and compare the talking and doing that may occur with different types of objects.

Session Objectives

In this session, students:

- Discuss role and use of objects in learning and teaching
- Discuss features of objects in learning conversations
- Reflect on how and why educators use objects in their interactions

Background Information for the Presenter

Informal science education institutions are places where objects are displayed for their authenticity, immediacy, interactivity, and cultural capital (Gurian, 1999). They include, but are not limited to, artifacts, specimens, artworks, live organisms, and interactive exhibits. They are what make these places different from other learning environments. These objects are the physical representations of the scientific knowledge – information, history, aesthetic, and significance (Tran & King, 2007). Traditionally, this information has been defined by curators and communicated by labels (Gurian, 1999); though increasingly, visitors are invited and encouraged to make their own interpretations and meaning from the objects (Roberts, 1997). The recognition of the constructivist perspective on learning is attributed to this shift (Rowe, 2001). "One important implication of constructivism is that the meanings people make as a result of the negotiation of different knowledges and ways of knowing cannot be judged according to authoritative standards of what is "correct" or "incorrect" as is often the case in more formal learning settings" (Rowe, 2001, p. 21).

This shift draws attention to how learners connect with the objects and how educators facilitate engagement with the objects. The multiple representations and interpretations of objects provoke affective connections among learners (Macdonald, 2004). Leinhardt and Crowley (2002) suggest that objects offer a degree of information unavailable in a two-dimensional image. They emphasize that it is often the smallness or largeness of an object, or its connection to real events or people, which makes it, and thus the wider learning experience in informal environments, truly memorable.

Consequently, educators are challenged to use objects as the primary vehicle for communicating scientific knowledge, while also inviting and encouraging learners to make personal connections and meanings with the objects and the knowledge they represent. To mediate a visitor's experience of an environment, educators need to unravel the complexities inherent in the objects and, at the same time, help individuals find points of personal connection and relevance. Thus educators must select from a range of interpretations to best suit their understanding of learners' needs. In so doing, they may address the provenance of the object, its social history or scientific significance, or they may simply encourage learners to observe an object and appreciate it for its own sake or aesthetic value.

Types and Characteristics of Objects

In this course, the term "objects" is used broadly to include all the "special things" in informal science education institutions, such as specimens, live organisms, artifacts, artwork, and interactive exhibits. We identify at least five different types of objects:

- Natural object (e.g., live and preserved plants and animals)
- Representational object (e.g., model, replica)
- Virtual/Digital object (e.g., video, simulation, SEM, x-rays, photographs)
- Artifactual objects (e.g., Darwin's microscope, rice bowl that survived the atomic bomb in Hiroshima)
- Interactive object (e.g., Bernoulli blower, tornado exhibit)

There are at least four features of these objects in informal environments that are starting points of ideas for conversations and elaborations that make them unique from other sources of experiences and information, such as books, televisions, and the Internet (Leinhardt & Crowley, 2002). An object may have more than one of these features.

- **Resolution.** The minute and subtle details of objects, such as bumpy scales of a snake or the stench of the corpse flower when it blooms.
- **Scale.** The smallness and largeness of objects, such as a steam engine from the Industrial Revolution the size of a room or the femur bone of a dinosaur that stands the height of the room.
- **Authenticity.** The realness of objects, such as the first underwater glider to traverse across the Atlantic Ocean autonomously, or a first edition of *On the Origins of Species*.
- **Value.** The uniqueness of objects, such as the only live white shark in captivity or a rock from the moon.

Conversing about Objects

Different types of objects promote different types of talk from learners (Ash, 2003; Eberbach & Crowley, 2005; Hohenstein & Tran, 2007). For example, Eberbach and Crowley (2005) compared how families explained pollination in their conversations at three different types of objects—natural, representational, and virtual. Explanations, in particular, are viewed as a higher-level thinking process (Keil, 2006); they result from human activities, and serve to generate knowledge and increase our understanding of phenomena (Wilson & Keil, 1998). Explanations are the core of theories, and so

explanations can be viewed as a useful tool to assess learners' current theories (Crowley et al., 2002). Explanations that arise in everyday conversation present excellent opportunities for children to articulate and revise their theories of scientific phenomena, with guidance from parents and other adults (Crowley, et al., 2002, p. 714). Eberbach and Crowley (2005) found that learners made more process explanations when exploring representational and virtual objects than with natural objects. Process explanations were accounts of what was happening and how it was happening, such as bees landing on flowers to drink nectar (what) and bees using their proboscis to drink the nectar (how). Children made more connections to school when exploring representational objects; and learners made more connections to everyday experiences when exploring natural objects than virtual objects.

Hohenstein and Tran (2007) explored learners' conversations at three artifactual objects that differed in their *resolution*, more specifically, the physical complexity and self-explanatory nature. They found the *resolution* of the objects might influence the types and quantities of questions and explanations learners made. Physical complexity is the intricate details of the object, and self-explanatory is the extent to which learners can explain the idea or concept the object represents simply by observing or moving the object itself. Hohenstein and Tran noted that visitors engaged in more explanations and asked more questions about objects that had greater physical complexity, and were more self-explanatory in nature. For instance, at one object, the intricate details and movable machinery prompted visitors to explain the mechanism, as they observed the machine move right in front of them. In comparison at another object, visitors were asked to reflect on the historical, social, and scientific significance of the object, though it possessed little context or detail of the event. In this case, explanations and questions from the visitors did not often occur.

Finally, Ash (2003) examined how families talked about life science topics at a variety of objects—natural, interactive, and virtual/digital—in an exhibition about frogs. She reported that families used biological themes, such as the life cycle of frogs and coloration for protection, as conversational points. The families used features of the objects, for instance the resolution of detail from a frog skeleton compared to a human skeleton and authenticity of live swimming frogs and tadpoles, to make process explanations about change from tadpole to adult frog and functional reasoning about the use of tadpole's tail and frog's legs. She found that children talked about the essence of animals (e.g., that they reproduce themselves and that they have life cycles); and adults used personification and mapped human characteristics to other species.

Engaging with Objects

Hands-on activities in science education are highly valued for promoting learning, though they have been highly criticized also. Additionally, "hands-on" exploration does not require learners to manipulate the materials physically, as long as they are actively engaged in the learning experience (Klahr, Triona, & Siler, 2008; Klahr, Triona, & Williams, 2007; Zacharia & Constantinou, 2008).

First, advocates for hands-on science argue that it promotes learning because (Flick, 1993): it is consistent with the concrete-to-abstract nature of cognitive development; it provides additional sources of brain activation via kinesthetic involvement; and its intrinsic interest increases motivation and engagement. Critics of

hands-on activities argue that they make learning less efficient and effective by (Hodson, 1996): producing confusing and inconsistent feedback; allowing learners to engage in off-task activities that produce irrelevant information; and providing inadequate mappings between the behavior of physical materials and their abstract representation in formal diagrams and equations. Second, whether virtual or physical materials were used had no effect on children's ability to learn from their own hands-on attempts to discover the causal factors in the distance traveled by mousetrap cars that they designed (Klahr, et al., 2007). Using another example, physical and virtual manipulatives can provide equally interactive experiences that enhance students' understanding of concepts related to temperature and changes in temperature (Zacharia & Constantinou, 2008).

The informal science education field is a proponent of hands-on activities for science learning, thus the more important discussion for us focuses on how we encourage learners to engage in hands-on activities and how we facilitate those experiences.

While it is well recognized that the only effective way to learn to do science is by doing science, it is also important for educators to understand that it is most effective for learners to do science alongside someone who is skilled and experienced, and thus can provide on-the-task support, critique, and advice, and is able to model the processes involved and invite criticism from the learner (Hodson, 1996). There is significant evidence to suggest that pure self-discovery learning does not support science learning (Mayer, 2004). When students learn science in classrooms with pure discovery methods and minimal feedback, they often become lost and frustrated, and their confusion can lead to misunderstandings (Brown & Campione, 1994). In informal environments, at exhibits that demonstrate counterintuitive phenomena, visitors are often left to ponder, "why did that outcome occur," which may be too challenging for most visitors to answer through self-experimentation at the exhibit. As a result, they either leave the exhibit or turn to an explanatory label for the answer (Gutwill, 2008). In a comparison study between direct instruction and discovery learning, researchers found that many more children learned from direct instruction than from discovery learning, and also when asked to make broader, richer scientific judgments, the many children who learned about experimental design from direct instruction performed as well as those few children who discovered the method on their own (Klahr & Nigam, 2004). Thus, while learners need enough freedom to become cognitively active in the process of sense making, learners also need enough guidance so that their cognitive activity results in the construction of useful knowledge (Mayer, 2004).

From his review of 40 years of research literature on discovery learning and constructivist teaching, Mayer concluded that while "activity may help promote meaningful learning, instead of behavioral activity per se (e.g., hands-on activity, discussion, and free exploration), the kind of activity that really promotes meaningful learning is cognitive activity (e.g., selecting, organizing, and integrating knowledge)" (Mayer, 2004, p. 17). He argued that rather than depending solely on learning by doing or learning by discussion, the most genuine approach to constructivist learning is learning by thinking. Thus instructional methods that rely on doing or discussing should be judged not on how much doing or discussing is involved, but rather on the degree to which they promote thinking and making connections. Guidance, structure, and focused goals should not be ignored.

When we consider how learners engage with the objects, we examine the ways in which they participate in, become involved with, and connect with the objects, and also what the educator does to guide, structure, and focus this engagement. We found that learners in informal environments may actively engage with objects in several ways (Tran, Werner-Avidon, & Randol, 2008), and that educators may facilitate this engagement using a variety of methods. We describe them here.

Engagement

- **Sense.** Sensory experiences of objects singularly, such as look, smell, touch, taste, and listen.
- **Compare.** Sensory experiences across multiple objects.
- **Experiment.** Manipulate, control, or handle objects to test ideas and assumptions.
- **Discuss.** Talk with others (peers or educators) about what happens, what they see, what they do.

Facilitation

- **Model.** Educator engages with the object(s) to demonstrate for learner(s) how to engage
- **Social.** Educator encourages learners to engage with objects with other learners
- **Prompt.** Educator invites and suggests ways for learner(s) to engage with objects

Session at a Glance

Task	Description	Estimated time (in minutes)
Quick Write	Students reflect on and write about their thoughts from the reading. They share their ideas on the role and use of objects in informal environments.	15
Midterm		40
Activity: *Teaching with Objects*	Working in small groups, students use the *Characteristics of Exemplary Activities & Facilitation* list to guide design of a program, activity, exhibit, or environment featuring one of four different objects—real specimens, photos, models and videos.	60
Research Discussion	Students do a jigsaw to discuss ideas from research on conversations about and engagement with objects.	30
Work with Partner	Students work with their partner to incorporate new ideas into the design of their activity	20
Homework	Readings & tasks are assigned.	5
	TOTAL: 2 hrs 50 minutes	**170**

Materials Needed

For the class:

- PowerPoint slides for Session 7: Objects & Engagement
- Data/digital projector
- Observation Questions poster (see Getting Ready)
- Debriefing the Activity chart (see Getting Ready)
- *Characteristics of Exemplary Activities & Facilitation* chart

For each participant

- 1 copy of "Ideas from Research – Conversing about objects" take home handout
- 1 copy of "Ideas to consider when teaching with objects"
-

For Cephalopod Objects Activity (4 groups of 4-5 students per group)

- Real Object: 1 to 2 real whole squid or octopus—frozen and thawed or fresh (or other organisms)
- Digital/Video Object: 3 to 4 videos of squid or octopus—especially capturing prey (or other organisms)
- Model/Representational Object: 1 model of squid or octopus (or other organisms)
- Digital/Photo Object: 5 to 6 photographs of different species of cephalopods, including some capturing prey (or other organisms)
- All groups: Arts and crafts materials—scissors, colored paper, glue, tape, pipe cleaners, etc

  Note to Facilitator*: Cephalopods, and specifically squid, are used in this session because they are intriguing organisms, and the four types of objects featured in this session are fairly easily attainable. If your institution has another organism, feel free to substitute as long as you can gather materials for all four types of objects.*

For Research Discussion: Ideas from Research Jigsaw Cards (small groups will need one copy of each card)

- Research Card #1: Promoting Meaningful Learning
- Research Card #2: Effect of Different Types of Objects
- Research Card #3: Family Interactions around Objects
- Research Card #4: Objects that Promote Conversations
- Research Card #5: Importance of Visitors Engaging in Conversations

Preparation of Materials

Note to Facilitator: *For large groups where there will be more than four or five individuals per group, consider having more than four groups, with a couple of groups working with another set of objects that are easily acquired, such as having two groups use the video or the real squid.*

1. Determine the focus of the activity.
   - Decide if you will use cephalopods as your focus or some other organism. The specific organism does not matter as long as you can obtain living or once-living specimens, video, models, and photographs of the organism.
2. Cephalopods
   - Whole squids can be purchased frozen in many grocery stores or fresh from seafood or bait stores. Preserved squid can be purchased from biological supply houses such as Carolina Biological.
   - Models of squid can be purchased or made from simple, inexpensive materials. Here is a link to a squid toy for purchase, and below are photographs for making your own models out of felt.
     - http://www.amazon.com/Safari-LTD-Monterey-Giant-Squid/dp/B0009JK9SA
     - http://anwo.com/store/squid.html
   - Videos can be found on free online video sites, such as YouTube. Here are some examples of squid videos. Have the webpages uploaded for the group.
     - http://www.youtube.com/watch?v=vT9fJLlFeKU
     - http://www.youtube.com/watch?v=OBg0k9GbHiw&feature=related
     - http://www.youtube.com/watch?v=URrXDJy1SGk&feature=related
     - http://www.youtube.com/watch?v=yTaEzlnw-LM&feature=related
   - Photographs can also be found online. We recommend images at least 500 dpi in resolution so the image prints fully on a piece of paper. Color printing is most ideal.
3. Prepare Observation Questions to be displayed.
   - Write out Observations Questions on a poster paper, and have them ready to post where everyone can see them during the sharing of the Activity: Cephalopods.
     - What are the learners and educator talking about?
     - How are the objects used in the conversations?
     - What are the participants doing with the objects?
4. Make research cards; one set per group.
   - Make "Ideas from Research–Conversing about Objects" research cards. Cut apart into separate cards. Each small group will need one copy of each card, and each group member will need a different card.
5. Duplicate handouts; one copy per student.
   - Key ideas from the Literature–Conversing about Objects
   - Ideas to Consider when Teaching with Objects.

6. Optional: Have available for display the *Characteristics of Exemplar Activities and Facilitation* chart that the class has been developing throughout the course.

7. Make the Debriefing the Activity chart.

Debriefing the Activity chart				
	video	photo	real-thing	model
engagement				
conversation				

Session Details

Quick Write

1. Students do Quick Write. Students write for three minutes on the following questions:

> Objects refer to special things in informal institutions—artifacts, exhibits, specimens, etc.
> - In this course and the Exemplar Activities, how are objects used to teach?
> - What do you talk about with learners while focusing on or using these objects?

2. Students share their thinking and conversations. Record the ideas on the board for everyone to see. Use the Discussion Map to facilitate the discussion.

> **Discussion Map**
> - 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

Objects for memories and conversations

1. Ponder and then discuss in small groups. Display the following two statements to focus students' attention on the conversations that objects promote. Ask students to think a moment about the meaning of the statement and their reaction to it—do they agree, disagree, why. They should form small groups and discuss their reactions.

- People visit informal environments for the memories and experiences that they create when they see, touch, smell, and interact with these objects (Gurian, 1999).
- The genius of informal environments exists somewhere in an analysis of how unique and powerful objects support learning in the form of conversations, which get elaborated as small clusters of individuals engage with objects (Leinhardt & Crowley, 2002).

2. Whole group discussion. Facilitate a whole group discussion. Use the Discussion Map as a guide the sharing out.

Discussion Map

- 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.

Starting points of conversations

1. Consider the following ideas. Share with students that there are four features of objects in informal environments that are argued to be starting points of ideas for conversations and elaborations that make them unique from images in books, televisions, and the Internet (Leinhardt & Crowley, 2002). Objects may have more than one of these features.

- **Resolution.** The minute and subtle details of objects, such as bumpy scales of a snake or the stench of the corpse flower when it blooms.
- **Scale.** The smallness and largeness of objects, such as steam engines from the Industrial Revolution the size of a room or the femur bone of a dinosaur that stands the height of the room.
- **Authenticity.** The realness of objects, such as a Mars rover or a first edition of *On the Origin of Species.*
- **Value.** The uniqueness of objects, such as the only live white shark in captivity or a rock from the Moon.

2. Whole group discussion. Ask participants to consider and respond to this question:

- How can these features be useful when thinking about the design and interactions in your activities?

Research Card Jigsaw

1. Introduce Research Card Jigsaw. Let students know that researchers have taken an even closer look at how learners talk about science ideas at different types of objects, and found that different types of objects may promote different types of talk. Tell the students each small group will receive a few research cards focusing on "Conversing about Objects". Each card features a piece of information that research has found out about teaching with objects. 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. Like a jigsaw puzzle, each member of the team is in charge of one of the "pieces."

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 on the card. They should also invite group members to discuss the topic on the card, including:

- Anything confusing about the idea on the card.
- Questions or issues 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 15-20 minutes of discussion, ask each group to share out any issues, ideas or questions that came up during their small group discussion. Also ask students to consider how these ideas about the ways in which learners talk about objects are similar and/or different from the conversations they had at the Cephalopod Activity.

Note to Instructor: *An overview of the content of the research cards is described here.*

- Learners make more process explanations when exploring representational and virtual objects than with natural objects (Eberbach & Crowley, 2005).
- Learners make more connections to school when exploring representational objects; learners make more connections to everyday experiences when exploring natural objects than virtual objects (Eberbach & Crowley, 2005).
- The *resolution* of objects (e.g., the physical complexity and self-explanatory nature of objects) may affect the types and quantities of

questions and explanations learners make (Hohenstein & Tran, 2007).

- The resolution in the details of objects, for instance, tools and moving parts in a Victorian workshop compared to a rice bowl from post-atomic bomb at Hiroshima, may prompt learners to make explanations about the mechanism at the former object, while be more terse at the latter object (Hohenstein & Tran, 2007).
- Families use biological themes, such as life cycle and protection, as entry points to learning conversations about life science topics at various types of objects (Ash, 2003).
- Families used features of the objects, for instance the resolution of detail from a frog skeleton compared to human skeleton and authenticity of live swimming frogs and tadpoles, to make process explanations about change from tadpole to adult frog and functional reasoning about the use of tadpole's tail and frog's legs (Ash, 2003).

Content explanation. ***Process explanations*** are accounts of what is happening and how it is happening, such as bees landing on flowers to drink nectar (what) and bees using their proboscis to drink the nectar (how). ***Physical complexity*** is the intricate details of the object, and ***self-explanatory*** is the extent to which learners can explain the idea or concept the object represents simply by observing or moving the object itself.

Explanations. Explanations, in particular, are viewed as a higher-level thinking process (Keil, 2006). They result from human activities, and serve to generate knowledge and increase our understanding of phenomena (Wilson & Keil, 1998). Explanations are the core of theories, and so explanations can be viewed as a useful tool to assess learners' current theories (Crowley, et al., 2002). Explanation episodes that arise in everyday conversation present excellent opportunities for children to articulate and revise their theories of scientific phenomena, with guidance from parents and other adults (Crowley, et al., 2002, p. 714).

4. Distribute "Key Ideas from Research-Conversing about Objects" take-home handout. Distribute the handout for students to use as a reference in the next activity.

Activity: Teaching with Objects

Introduce the Activity

1. Introduce the task. Let students know that this next activity will give them the opportunity to think more deeply about objects, and apply some of their understanding. They will work in four groups (less than 6 per group is ideal) for 15 minutes to design an educational experience to teach

about **cephalopod behavior or adaptations such as *how cephalopods catch their food*** to visitors. They will then share their design in a 5-minute skit.

2. Purpose of the activity. Let students know it is understandable that 15 minutes is not enough time to create a great program, activity, exhibit, or environment. Explain that there are two purposes for this activity.

- **Application.** Apply our understanding of how people learn and how to support that learning in the design of educational materials and experiences.
- **Affordances.** Think deeply about how four different types of objects allow for different ways to engage and interact.

3. Instructions for preparing the skits. Let students know that they will design an activity or program, including how an educator facilitates the interaction. They will share their design in the form of a skit. They should design the flow of the whole experience, but will only "teach" a 5-minute clip in the skit. For their skits, each group needs to decide:

- What will the group design?
  - Program or activity
- What is the interaction?
  - Feature the object in a classroom-based program, cart activity on gallery floor, at an exhibit, exploration in the discovery lab, show in the auditorium, etc.
- Who is the audience?
  - School group, family, general public, adults, etc.
- Who are the "educator(s)" and "learners"?
  - One or more member(s) of the group is designated as the "educator"; other members of the group are designated as the "learners". Also, if the group needs or wants more learners, everyone else can play the role of learners, e.g., they can be members of the general public in an auditorium, or be students in a school group.

Design & Present the Activity

1. Explain activity and distribute the materials. Let students know that each group will have one of following types of objects and access to other materials such as paper, markers, scissors, tape (optional). The program or activity they design must feature the object; use the additional materials available only to supplement their design.

The objects

- Real, intact dead squid
- Model of squid
- Video of squid
- Photographs of squids and other cephalopods

Note to Instructor. *The other materials, i.e., paper, markers, scissors, tape, etc., are optional. Some instructors have found that these materials distracted their students from using the "objects" in their design. If you make these materials available, emphasize to students that the featured objects are the focus of their design, and then monitor their use of the other materials.*

2. Call attention to resources for design. Remind students that they should use the following materials to guide the design of their activity and doing their skit.

- *Key Ideas from Research-Conversing about Objects*
- Distribute the *"Ideas to consider when teaching with objects"* handout.
- Display the *Characteristics of Exemplary Activities & Facilitation*.
    - Allow opportunities for visitors to engage in inquiry including exploration and investigation, but also in making explanations and application
    - Is "minds-on" (not just hands-on), interactive, fun, and contains a "hook"
    - Encourages questions from visitors and follows the interests of the learner
    - Encourages and provides opportunities for discussion/discourse and other social interactions between visitors or family/group members
    - Includes opportunities to engage with and manipulate objects, experiences and conversations in a social setting
    - Uses the specialness of objects to elicit conversations that support learning
    - Includes opportunities for learners to engage in various teaching approaches including some or all of the following: free exploration, guided and open inquiry and problem solving
    - Includes opportunities for visitors to make meaning individually, with peers and with someone more knowledgeable (e.g. facilitator/knowledgeable visitor)

3. Circulate. While students are designing their interaction, circulate around the room to offer supplies and answer questions pertaining to the task.

4. Give a reminder about skit presentations. Remind students that each group will "teach" a 5-minute piece of the whole interaction as a skit using the educational materials or environment that the group designed the interaction around. They will need to describe the context of the interaction to everyone including:

- What did the group design?
- What is the interaction?
- Who is the audience?
- Who are the educator(s) and learners?

5. Post *Observation Questions*. Post the Observation Questions on the board. Let students know that while they are observing, they will need to gather observation data and take notes to answer the following questions as they watch each groups skit

- What are the participants doing with the objects?
- How are the learners and educator talking about the objects?
- How do you know? What is your evidence?

6. Remind students of the purpose. Remind students that the task is not to determine whether one type of object is better than the other, or the effectiveness of one group over another. The purposes are to *apply* understanding of how people learn, and *notice* how each type of object allows for different ways of engaging and interacting.

7. Groups perform skits. Ask for groups to volunteer to perform their skits. End each presentation on time so that every group has the opportunity to share their activity

8. Review notes between groups. After each group presents, give everyone a few minutes to review and clean up their notes and prepare for the next group.

> ***Note to Instructor:*** *(1) After each group presents, give everyone a few minutes to gather their notes and prepare for the next group. (2) Keeping to time can be challenging, as students are excited to share the idea they designed. Give them at least five minutes to present—after that, cut them off based on whether it appears they have done enough in their presentation to give observers the chance to record their observations. (3) If necessary, remind students to refrain from placing value judgments on one type of object over another, or effectiveness of one group over others. The task is to pay attention to how people use the objects and what they talk about.*

9. Groups clean up their materials. After all the groups have finished, ask them to place their materials back on their trays, and move the tray to the side of the room out of the way.

10. Partners (or small groups) compare notes. Let students know that the debrief discussion will focus on answering the Observation Questions according to the type of objects used in the activity. Ask them to discuss and compare their observation notes with a partner (or in a small group).

Debrief the Activity

1. Display the chart. Display the "Characteristics of Engaging and Conversations with Objects" chart. Ask students to share the observation data for each of the observation questions, as you record their ideas in the respective section of the "Characteristics of Engaging and Conversations with Objects" chart. Use the questions below to facilitate the conversation, discussing each object in turn.

2. Students share observation data with whole group. Ask students to share the observation data for each of the observation questions, and record their ideas in the respective section of the Debriefing the Activity charts.

- What are the learners and educator talking about?
- How are the objects used in the conversations?
- What are the participants doing with the objects?
- How did people engage with the models? Video? Photo? Real thing?
- What kind of conversation happened?
- Why do you think that is?

Encourage the students to ask questions of each other. Explicitly ask individuals to respond to other people's comments. Use the Discussion Map below as a guide to help you facilitate the discussion.

Discussion Map

- 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.

Work with partner

1. Partners discuss their activity. Students work with their partner to think about how they use, talk about, and encourage engagement with objects in their activity to promote learners to talk about the scientific ideas, using the handout as a guide.

2. (Optional) 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:

- Allow opportunities for visitors to engage in inquiry including exploration and investigation, but also in making explanations and application
- Is "minds-on" (not just hands-on), interactive, fun, and contains a "hook"
- Encourages questions from visitors and follows the interests of the learner
- Encourages and provides opportunities for discussion/discourse and other social interactions between visitors or family/group members
- Includes opportunities to engage with and manipulate objects, experiences and conversations in a social setting
- Uses the specialness of objects to elicit conversations that support learning
- Includes opportunities for learners to engage in various teaching approaches including some or all of the following: free exploration, guided and open inquiry and problem solving
- Includes opportunities for visitors to make meaning individually, with peers and with someone more knowledgeable (e.g. facilitator/knowledgeable visitor)

3. 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.
  - Ch 7, Culture, Diversity & Equity, p. 119-137
- Paper.
  - Crowley 2001. Parents explain more to boys than girls.
- Castro, P & Huber, M.E. (2008). *Marine Biology*, 8th ed. McGraw-Hill Higher Education.

- Ch 18, The impact of humans on the marine environment, p. 406-423.

Task

- Students consider how they use objects to engage learners and support learning in their activity.

Key Ideas from the Literature: Conversing about Objects

Research Card #1: Promoting Meaningful Learning

While "activity may help promote meaningful learning, instead of behavioral activity *per se* (e.g., hands-on activity, discussion, and free exploration), the kind of activity that really promotes meaningful learning is cognitive activity (e.g., selecting, organizing, and integrating knowledge)" (Mayer, 2004, p. 17). Rather than depending solely on learning by doing or learning by discussion, the most genuine approach to constructivist learning is learning by thinking. So instructional methods that rely on doing or discussing should be judged not on how much doing or discussing is involved, but on the degree to which they promote thinking and making connections. Guidance, structure, and focused goals should not be ignored.

Research Card #2: Effect of different types of objects

Eberbach and Crowley (2005) compared how families explained pollination in their conversations at three different types of objects—natural, representational, and virtual.

— Learners make more process explanations when exploring representational and virtual objects than with natural objects

— Learners make more connections to school when exploring representational objects; learners make more connections to everyday experiences when exploring natural objects than virtual objects

Process explanations are accounts of what is happening and how it is happening, such as bees landing on flowers to drink nectar (what) and bees using their proboscis to drink the nectar (how).

Research Discussion: Research Cards (pg. 2 of 3)

Research Card #3: Family Interactions around Objects

Ash (2003) examined how families talked about life science topics at a variety of objects—natural, interactive, and virtual/digital—in an exhibition about frogs.

— Families use biological themes, such as life cycle and protection, as entry points to learning conversations about life science topics at various types of objects

— Families used features of the objects, for instance the resolution of detail from a frog skeleton compared to human skeleton and authenticity of live swimming frogs and tadpoles, to make process explanations about change from tadpole to adult frog and functional reasoning about the use of tadpole's tail and frog's legs (Ash, 2003).

Process explanations are accounts of what is happening and how it is happening, such as bees landing on flowers to drink nectar (what) and bees using their proboscis to drink the nectar (how).

Research Card #4: Objects that Promote Conversations

Hohenstein and Tran (2007) explored learners' conversations at three artifactual objects that differed in their *resolution*, more specifically, the physical complexity and self-explanatory nature.

— The *resolution* of objects (e.g., the physical complexity and self-explanatory nature of objects) may affect the types and quantities of questions and explanations learners make

— The resolution in the details of objects, for instance, tools and moving parts in a Victorian workshop compared to a rice bowl from post-atomic bomb at Hiroshima, may prompt learners to make explanations about the mechanism at the former object, while be more terse at the latter object

Physical complexity refers to the intricate details of the object, and ***self-explanatory*** is the extent to which learners can explain the idea or concept the object represents simply by observing or moving the object itself.

Research Discussion: Research Cards (pg. 3 of 3)

Research Card #5: Importance of Visitors Engaging in Explanations

Explanations, in particular, are viewed as a higher-level thinking process (Keil, 2006). They result from human activities, and serve to generate knowledge and increase our understanding of phenomena (Wilson & Keil, 1998). Explanations are the core of theories, and so explanations can be viewed as a useful tool to assess learners' current theories (Crowley, et al., 2002). Explanation episodes that arise in everyday conversation present excellent opportunities for children to articulate and revise their theories of scientific phenomena, with guidance from parents and other adults (Crowley, et al., 2002, p. 714).

Key Ideas from the Literature: Conversing about Objects

While "activity may help promote meaningful learning, instead of behavioral activity *per se* (e.g., hands-on activity, discussion, and free exploration), the kind of activity that really promotes meaningful learning is cognitive activity (e.g., selecting, organizing, and integrating knowledge)" (Mayer, 2004, p. 17). Rather than depending solely on learning by doing or learning by discussion, the most genuine approach to constructivist learning is learning by thinking. So instructional methods that rely on doing or discussing should be judged not on how much doing or discussing is involved, but on the degree to which they promote thinking and making connections. Guidance, structure, and focused goals should not be ignored.

Findings from three studies on un-facilitated conversations:

1. Eberbach and Crowley (2005) compared how families explained pollination in their conversations at three different types of objects—natural, representational, and virtual.
Learners make more process explanations when exploring representational and virtual objects than with natural objects
Learners make more connections to school when exploring representational objects; learners make more connections to everyday experiences when exploring natural objects than virtual objects

Process explanations are accounts of what is happening and how it is happening, such as bees landing on flowers to drink nectar (what) and bees using their proboscis to drink the nectar (how).

2. Hohenstein and Tran (2007) explored learners' conversations at three artifactual objects that differed in their *resolution*, more specifically, the physical complexity and self-explanatory nature.
The *resolution* of objects (e.g., the physical complexity and self-explanatory nature of objects) may affect the types and quantities of questions and explanations learners make
The resolution in the details of objects, for instance, tools and moving parts in a Victorian workshop compared to a rice bowl from post-atomic bomb at Hiroshima, may prompt learners to make explanations about the mechanism at the former object, while be more terse at the latter object

Physical complexity refers to the intricate details of the object, and ***self-explanatory*** is the extent to which learners can explain the idea or concept the object represents simply by observing or moving the object itself.

3. Ash (2003) examined how families talked about life science topics at a variety of objects—natural, interactive, and virtual/digital—in an exhibition about frogs.
Families use biological themes, such as life cycle and protection, as entry points to learning conversations about life science topics at various types of objects
Families used features of the objects, for instance the resolution of detail from a frog skeleton compared to human skeleton and authenticity of live swimming frogs and

tadpoles, to make process explanations about change from tadpole to adult frog and functional reasoning about the use of tadpole's tail and frog's legs (Ash, 2003).

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References for Key Ideas from the Literature

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Handout: Work with Partner

Ideas to Consider when Teaching with Objects

CONVERSATIONS: How are learners and facilitator talking about the objects?

	Description	Examples
Identification	Calling out or naming objects, or parts of objects.	- This is a fiddler crab. - There's the honeybee. - That is the operculum of a fish.
Description	Elaborating upon elements or details of the object.	- The whelk has a soft body and a hard shell. - The bee is taking nectar from the flowers.
Explanation	To make clear the cause, origin, or reason of; to account for. Reasoning causal relations, processes, scientific principles, and analogies.	- Dead zones means there is no oxygen in the water, and this is bad because animals cannot live without oxygen in the water. - Oh, see!? He [the bee] takes nectar and the pollen gets stuck on him, and then he goes to another flower and another flower. That's how pollen gets spread.

ENGAGEMENT: How are the learners engaging with the objects?

Sense	Examines object—listen, touch, smell, & look at (sensory).	- Learner touches, smells, looks at, or listens to object.
Manipulate	Manipulates, or makes changes to, objects in order to think about the topic from a new or different perspective—compare & contrast.	- Learner compares features or characteristics between objects.
Experiment	Makes a hypothesis about an observation and tests it out—"I wonder if …."	- Learner makes a hypothesis, controls variables, and tests ideas.
Discuss	Talks about the object.	- Learner converses about what she or he senses, does, or thinks about the objects.

FACILITATION: How is the educator facilitating learners' engagement with the objects?

Learner		
Learner-directed	Learner(s) engages with object(s) on their own	- Learner approaches the tank and touches a seastar
Educator		
Models	Educator engages with the object(s) to demonstrate for learner(s) how to engage	- Educator touches an otter pelt with two fingers, and urges learner to do the same
Social	Educator encourages learners to engage with objects together	- Educator asks learners to work together to sort a collection of shells
Prompt	Educator invites and suggests ways for learner(s) to engage with objects	- Educator proposes that learners compare the features of two skulls

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