



*A professional learning program
for informal science educators*

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**THE LAWRENCE
HALL OF SCIENCE**
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Overview

Module 1 introduces participants to the methods and theoretical foundations of the *Reflecting on Practice*TM program.

Session 1 introduces the program and presents **foundational ideas on learning** that will be explored further throughout the program. It initiates discussions on the important contributions of informal science learning environments (museums, zoos, aquariums, science centers, etc.) as places where people come to learn and develop interests in science, as well as to become motivated to pursue careers in science.

Session 2 engages participants in **discussions about professional learning and reflective practice**. It introduces them to the **professional learning community** framework and **the use of tools**, such as video, to aid reflection.

In Session 3, participants gain insight into the **nature and practices of science** in the best way possible: by *doing* and *reflecting* on science. They have the opportunity to discuss the seminal question, “What is science?” and then, “What is the value and effect of a deeper understanding of—and reflection on—the nature and practices of science?”

The program presents opportunities for informal educators to

- learn about and discuss science pedagogical content;
- begin to make their practice public, as they create methods and tools to facilitate observations;
- initiate habits of reflection in their practice; and
- engage in critical discussions and reflections with colleagues.

Module 1. Session 1.

Learning Beliefs, Behaviors, and Goals

Session Overview

This session serves as an introduction to the *Reflecting on Practice* program. It opens discussions about **how people learn** by introducing foundational ideas on learning. It also highlights the important contributions of **informal science learning environments** as places where people come to learn and develop interests in science.

Reflecting on Practice is a professional learning program designed for educational professionals in informal science learning environments. In Session 1, participants learn about the major components of the program, and determine how they themselves will be involved and what their commitments will be. In this session and those to come, participants discuss and apply pedagogical knowledge and skills that support science literacy among visitors to informal environments.

Session Objectives

- Determine personal goals and agendas for participating in the program.
- Identify personal beliefs on learning, behaviors in learning, and goals for learning.
- Discuss the complexity of learning, and how this complexity pertains to learning and teaching science in informal environments.

SESSION AGENDA		
Routine	Description	 Estimated Time (in minutes)
Introduction (Part 1): <i>Goals and Objectives of Reflecting on Practice</i>	Goals and purpose of the program are introduced and Learning Journals distributed.	7
Thought Swap: <i>Getting to Know Each Other</i>	First with a partner and then with the whole group, participants share ideas on a series of questions about (a) informal science education and (b) teaching and learning goals.	20
Introduction (Part 2): <i>The Program and Session 1</i>	Overview of the program and Module 1 is presented. Objectives of Module 1, Session 1 are introduced.	10
3-2-1-Bridge: <i>Ideas on Learning</i>	Participants jot down initial ideas on how they think people learn. They will revisit these thoughts in a later session.	10
Turn & Talk: <i>Learning Beliefs and Behaviors</i>	Participants share their beliefs and assumptions about learning as they “turn & talk” to someone next to them. A whole-group share-out follows.	10
Break Option		8
Hands-on: <i>Cup & Card</i>	Small groups are presented with a hands-on challenge activity to promote discussion about learning and pedagogy.	30
Walkabout Research Discussion: <i>Five Foundational Ideas on Learning</i>	Small groups circulate to five different charts that address how key ideas from the literature might be used to inform their practice. At each chart, groups record their ideas and add to what others have already charted.	30
Let’s Talk Practice: <i>Applying the Five Foundational Ideas</i>	Newly reconfigured small groups work together to make connections from the Research Discussion, and apply ideas to their own practices in response to a prompt.	20
Closing Thoughts: <i>Personal Goals for the Program</i>	Participants gather their thoughts and write down personal goals in their Learning Journals.	3
Continue the Learning	Participants discuss the parameters and expectations for tasks outside of interactive sessions.	2
Total Estimated Time		150 mins. (2.5 hrs.)

MATERIALS



For the facilitator

- Data projector
- 5 chart paper posters for *Five Foundational Ideas on Learning* (see **Getting Ready #10**)
- PowerPoint slides for Module 1, Session 1: *Learning Beliefs, Behaviors, and Goals* (from reflectingonpractice.org)

Note: If you prefer, you may recreate the content of the PowerPoint slides on chart paper for display, or on a whiteboard as you go. See Getting Ready #5.

For each participant

- **Learning Journal** (see **Getting Ready #2**)
- Binder to hold all program handouts (*or have participants bring their own binders/material holders to each session*)
- Handout: **About the Program: Reflecting on Practice**
- Handout: *Five Foundational Ideas on Learning*
- Handout: **Applying the Five Foundational Ideas**
- Handout: **Science Content for Cup & Card** (optional)
- Reading for this session (see **Getting Ready #1**)

For each small group (4–6 participants), for Walkabout Research Discussion

- 1 colored marker, different color from each of the other small groups

For each small group, for Hands-on: Cup & Card

- 1 dishpan filled with water
- 1 tray or box in which to place materials
- 4–6 flexible plastic cups (squat Solo® type with large mouth)
- 4–6 3" x 5" pieces of plastic sheet cut from transparent report covers OR laminated 3" x 5" cards OR a few cards from a deck of cards
- 2–3 5" x 8" pieces of plastic sheets cut from transparent report covers, or laminated 5" x 8" cards
- 2 graduated cylinders (50 ml)
- 2 Erlenmeyer flasks, 250 and 500 ml
- 2 rigid plastic glasses
- 4–6 other shapes and sizes of cups, flasks, jars with various mouth shapes and sizes (e.g., barware such as martini and shot glasses)
- Sponge and paper towels
- ~ 50 pennies (for the Penny Challenge)

Getting Ready

1. Review the content relevant to this session:

- a. **About the Program: *Reflecting on Practice*** (handout)
- b. ***Five Foundational Ideas on Learning*** (handout)
- c. **Applying the Five Foundational Ideas** (handout)
- d. *Learning Beliefs, Behaviors, and Goals* (PowerPoint slides)
- e. **Readings for this session** (below)

For the participants:

- [*Surrounded by Science*](#) (Chapter 1: “Informal Environments for Learning Science”)

For the facilitator:

- [*How People Learn*](#) (Chapter 5: “Mind and Brain”)
- [*Learning Science in Informal Environments*](#) (Chapter 1: “Introduction”)

2. If you’ve decided to supply the Learning Journals yourself (spiral-bound notebooks, 3-ring binders, etc.), have them ready to distribute.

Decide how you’d like participants to record in their journals: free-form style or in a specific way you designate.

***NOTE:** The Learning Journal is a record book in which participants keep their written thoughts in one place. It is both a tool for learning, as participants make their thinking visible in writing, and for reflection, as participants review past entries to notice patterns and changes in their thinking.*


3. Consider parameters and expectations for **Continue the Learning**—that is, assigned work for continued learning outside of the interactive sessions. This work generally consists of two kinds of assignments: reading, and (starting in Module 2) collecting, watching, and discussing videos.

***NOTE:** It is certainly helpful for participants to do reflective tasks outside of interactive sessions, so they can keep the ideas brewing, share what they are trying, and seek help from one another. However, it is also understandable that these tasks may not be feasible for all participants. Some may be hourly paid staff; will they be paid for time spent doing these tasks outside of session hours? Additionally, participants likely already have too much work; where and how will time be made for this “homework?”*

In preparing to lead each session, the facilitator should review all handouts and suggested readings, including readings listed for the participants. (Readings listed for the facilitator may also be shared with participants, if you choose.)

The first of these three readings, from *Surrounded by Science*, may be assigned as participant reading under **Continue the Learning** at the end of the session. The other two, from *How People Learn* and *Learning Science in Informal Environments*, are recommended background reading for the facilitator. (All readings are free and downloadable from National Academy Press. Titles can be searched online at www.nap.edu/topic.)

The *Reflecting on Practice* professional learning program requires that both institutions and individuals invest time and resources for the professional growth of the participants. **Institutions adopt the program** and allocate time and space for staff to engage, learn, and test out new ideas. **Individuals participate in the program** and commit time and effort to reflect on, make public, and improve their practice.


Concerns expressed during discussions of the **About the Program**  **handout** may include: time it will take to participate and do the tasks on top of busy work schedules; the logistics of making—and anxiety about sharing—videos of their teaching; how this program is related to current/changing conditions at their particular institution; how participation can/will affect job security and performance evaluations; and value and purpose of the program for them, for the department, and for the institution.

Before deciding on quantity of work beyond the interactive sessions, the Facilitation team should confer with participants' supervisors and senior management to determine whether these ongoing reflective tasks will be financially or otherwise supported.

Every module after the first includes a session in which participants engage in **Video Reflection**; first with the whole community, guided by the facilitator, and then in two or three self-facilitated sessions in small groups with their critical colleagues.

Video Reflections are driven by each individual's questions about her own practice, and as such may require participants to record a different video for each reflection.

4. Make sure your room has sufficient space for participants to form two parallel lines for **Thought Swap**.
5. Make sufficient copies of handouts:
 - **About the Program: *Reflecting on Practice*** (1 per person) (See note in margin)
 - ***Five Foundational Ideas on Learning*** (1 per person)
 - **Applying the Five Foundational Ideas** (1 per person)
 - Optional: **Science Content for Cup & Card** (1 per person)

Note: All question prompts (and instructions for the Cup & Card activity) in the Session Step by Step directions are also included in the PowerPoint slide deck. However, if you have decided to use chart paper or whiteboard displays instead of the PowerPoint slides, prepare for the session by reading through the **Step by Step** in advance; look for the projector icon () and record the prompts/instructions on chart paper or whiteboard.

6. Prepare for **Cup & Card**. For each small group of 4–6 participants, prepare a tray of the items listed under **Materials** for the Cup & Card activity. (Keep the pennies separate; you'll distribute them to each group once it appears they are comfortable with the first part of the challenge.) Try out a few of the materials so you are comfortable with the activity. Some things to try include different combinations of glassware, amounts of water and sizes of plastic cards.

7. Review the optional handout **Science Content for Cup & Card** so you are comfortable with the content. Decide whether or not you will copy this optional handout for your participants. Keep in mind that the purpose of the activity is not to reach a complete understanding of the physics concepts, but rather to initiate discussions about beliefs and attitudes about learning and what supports learning.
8. Prepare five chart-paper posters for the **Research Discussion**. Title each of the five sheets with a short description of one of the **Five Foundational Ideas on Learning**:
 - **Learning is an active process.**
 - **Learning builds on prior knowledge.**
 - **Learning is more effective when situated in an authentic context.**
 - **Learning occurs in a complex social environment.**
 - **Learning requires motivation and cognitive engagement.**

***NOTE:** Small group sizes of 2–6 will work well for this activity. If you have fewer than 10 participants (which means that you can't start off a group of two at each poster), it is fine to have some of the posters unoccupied at any given time. Eventually, each group will be able to discuss and record at each of the posters. A smaller group just means that fewer participants will comment on any one poster.*

The purpose of **Cup & Card** is to provide a shared “adult learning experience” for participants to reflect on during subsequent discussions about learning. This activity was chosen, in part, because many educators are unfamiliar with the physics concepts addressed in the activity—and are therefore placed in the role of *learner* for Cup & Card. This nicely sets up the post-activity discussion about *what they learned* and *how they learned it*.

If you would prefer to use a different activity to place your educators in the role of learner, refer to the “Principles of Learning Design” (in the [Front Matter](#)) and let it guide you in choosing, creating, or revising another activity.



10 minutes



A **professional learning community** is a group of practitioners who share and critically examine their practice in a way that is ongoing, reflective, collaborative, inclusive, learning-oriented, and growth-promoting.

Session 1: Step by Step

Introduction (Part 1):

Goals and Objectives of Reflecting on Practice

1. Introduce goals and objectives of the program.

Display the program objectives and share the following:

- a. *Reflecting on Practice* is a modular program designed for adoption by informal science learning environments so that all educators in the organization can participate and learn together.
- b. The goal of the program is to advance the informal science education field by cultivating communities of learners among its professionals.
- c. The program has three primary objectives:
 - To build shared language and understanding among professionals by relating research to practice.
 - To engage practitioners in habits of reflection, including observing their own teaching, as a means to develop their practice and make it public.
 - To nurture a tradition of continued professional learning among participants, and thereby build a **professional learning community**.

Important: Emphasize that this program is **not** intended as a blueprint for how to teach. Some participants already bring a wealth of knowledge, experience, and pedagogical grounding to the program. *Reflecting on Practice* is an opportunity for practitioners of all levels of experience to learn from one another, develop a shared language on educational practice, and exchange ideas on how they teach.

2. Distribute and introduce Learning Journals.

Let participants know:

- a. **Learning Journals** are for their private use, to record in as they go through the program.
- b. The journals should be used to record their thoughts as they reflect on and learn about their own practice. Anything and everything can be entered in the journal. Use words, sketches, diagrams, etc. to express ideas.

- c. There will be opportunities to reflect and write during interactive sessions (e.g., “Quick Writes,” “Closing Thoughts”) as well as outside of the sessions.
3. Have all participants set up their journals in the way you decided on during **Getting Ready**.

Thought Swap: Getting to Know Each Other



25 minutes

1. Form two lines.

Ask participants to form two lines facing one another, making sure each person in one line has a partner in the facing line. An easy way to ensure this is to have people across from each other shake hands. Everyone needs a partner; if there is an odd number, someone from the facilitation team should join the line.

2. Introduce the format.

Tell participants how the **Thought Swap** works:

- a. There is a set of questions for participants to discuss.
- b. You (the facilitator) will ask one question at a time.
- c. Participants will have 2–3 minutes to discuss their responses for each question with their partners.
- d. When time is up, you will initiate the “touch of silence” down the two lines until the whole group is quiet and ready for the next question.

3. Display the first question:

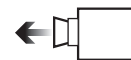
How might you describe informal science education compared to formal science education? (How do they overlap, and how are they different?)

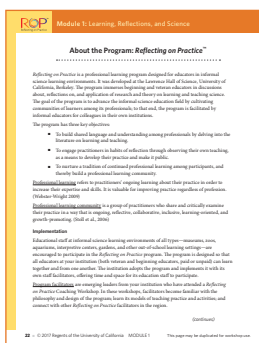
As participants discuss the question with their partners, discreetly walk up and down the lines to get an overview of what partners are discussing.

- **Listen to the noise.** Give participants 2–3 minutes to talk. If after 3 minutes the noise level is still fairly high, they may need an additional minute or two to talk. If the noise level *drops* (indicating that most discussion has stopped), initiate the “touch of silence” before the discussions spontaneously start up again.
- **Ask for volunteers.** Depending on available time and size of community, encourage 2–4 volunteers to share what they discussed with their partner. Participants can share their own

Thought Swap is a whole-group discussion routine to accustom participants to sharing their ideas, first with a partner and then with the whole group. (Some facilitators choose to join in Thought Swap to share and listen to ideas during the activity.)

Touch of silence: Facilitator touches the shoulder of the first person in each line. Those individuals stop talking and touch the shoulders of the persons next to them, who also stop talking and touch the shoulders of the persons next to them...and so on down the two lines.





thoughts, what their partner shared, or what they talked about together.

- **Create new partners.** Ask the person closest to you from *one line* to move to the other end of his or her line, and have everyone from that line move up one space. This establishes new sets of partners for the next question.

4. Display the second question and repeat Thought Swap routine from #3 above:

What are your goals when interacting with the public (your learners)? (What do you want visitors to learn when they visit your institution?)

5. Display the third question and repeat Thought Swap:

Recall an occasion when you thought you were at your best, teaching—or saw someone else teaching in a way that excited or inspired you. What was especially effective about it?

6. Display the fourth question and repeat Thought Swap:

What do you think (hope) this program will provide you for your practice?

Introduction (Part 2): The Program and Session 1

1. Introduce modular design and the big ideas of *Reflecting on Practice*.

Distribute the **About the Program: Reflecting on Practice** handout and give participants a few minutes to read about the program.

2. Discuss handout.

Once most participants have had a chance to review the handout, invite questions, comments, and concerns for discussion. (See sidebar next to **Getting Ready #5** for concerns that may arise when discussing the **About the Program** handout.)

3. Emphasize learning opportunity and professional recognition.

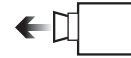
Let participants know the extent to which senior management supports and values their participation. Tell participants that this program is an opportunity for learning about their own practice for professional growth and career advancement. For those who are interested, there is also opportunity for acquiring professional recognition after completion of this program. Let them know the following:

Reflecting on Practice is a Learning Partner with the **Association of Zoos and Aquariums (AZA)**; an approved continuing education provider for the **National Association for Interpretation (NAI)**; and a special partner with the **Association of Science –Technology Centers (ASTC)**. If they choose, participants can earn elective or continuing education credit towards NAI certifications, and/or the AZA Professional Development Certificate in Education and Interpretation. For more information, refer them to reflectingonpractice.org.

4. **Display and introduce objectives of Module I, Session 1** and invite questions for clarification.

Program objectives:

- To identify your beliefs on learning, behaviors in learning, and goals for learning.
- To discuss the complexity of learning, and how this complexity is relevant to learning and teaching science in informal environments.
- To determine personal goals and agendas for participating in this professional learning program.



3-2-1 Bridge: Ideas on Learning



10 minutes

1. **Introduce 3-2-1 Bridge.**

Have participants take out their **Learning Journals**. Describe that in this routine they will be given a prompt and asked to record their thoughts about it in three phases. Ask them not to overthink their responses! This is an opportunity to freely brainstorm their initial thoughts, and there is truly no right or wrong response.

2. **Display prompt:**

How do people learn?

3. **Ask participants to “record 3 words.”**

Have them quickly write three words that come to mind when they think about how people learn.

4. **Have them “ask 2 questions.”**

Now ask participants to write two questions they wonder about when thinking about how people learn.



This response may take a little more time for participants to complete than the first two.



5. Ask them to “develop an analogy or metaphor.”

Display the definitions and have participants write one analogy or metaphor that encapsulates their ideas about how people learn. (These definitions are adapted from literarydevices.net.)

An **analogy** is a comparison in which an idea or a thing is compared to another thing that is quite different from it. It “explains” that idea or thing by comparing it to something that is familiar.

Example: How a doctor diagnoses diseases is like how a detective investigates crimes.

Metaphor is a figure of speech that makes an implicit, implied, or hidden comparison between two things that are unrelated but share some common characteristics. In other words, a resemblance between two contradictory or different objects is made based on one or more common characteristics.

Example: It’ll be **clear sailing** from now on. (This implies that clear sailing augurs well; the future will be without hardships)

6. Conclude 3-2-1 Bridge routine.

Let participants know they will return to these ideas about learning later in the session and throughout the program. Before they put away their journals, remind them to date and title the entry “3-2-1 Bridge: Ideas on Learning,” so they can easily find this entry later. Have them put their learning journals away for now.

10 minutes



Turn & Talk: Learning Beliefs & Behaviors

1. Introduce Turn & Talk routine.

Tell participants they will now have the opportunity to share their beliefs and assumptions about learning as they “turn & talk” to someone next to them.

2. Display questions for Turn & Talk discussion:

- What are the observable characteristics (signs) that learning is happening?
- What are the conditions that encourage and support learning?



3. Initiate “Turn & Talk.”

Tell participants to turn to someone next to them and talk about the two questions. Remind participants that they should make sure everyone has the opportunity to share his or her ideas over the next 5 minutes.

4. Begin Whole-Group Share.

After 5–7 minutes of partner talk, call “time” and invite participants to share what they talked about with the whole group. Say that they can respond to one question at a time, or to a combination or synthesis of both questions. Facilitate the discussion using the following steps:

- Listen to the noise. When noise level drops, partner talk is mostly done and group discussion can begin.
- Invite and listen to their responses. Record ideas on the board as you facilitate the discussion.
- Encourage participants to elaborate on their thinking by providing explanations, evidence, or clarifications.

Suggested probing questions:

- What makes you think that?
- Please give an example from your experience.
- What do you mean?
- Wait sufficiently long for participants (especially the quieter ones) to share ideas, and stay neutral in your reaction to all comments.
- Draw others into the conversation by asking them to react and respond to what is being shared. Ask for alternative viewpoints, agreements, or disagreements.

Suggested probing questions:

- Can anyone add something to that comment?
- Who would like to share an alternative opinion

5. Transition to Activity.

When no more new ideas are being shared, direct participants’ attention to the board where their ideas were recorded. Tell them to keep these ideas in mind during the next task.

By the end of the **Turn & Talk** whole-group discussion, the group will have generated many ideas on the board about how to tell if someone is learning and how to support learning. Refer to this list of ideas later, during the debrief discussion for the **Cup & Card** activity.

Facilitating Whole-Group Share.

It takes practice and patience to facilitate whole-group discussions that are substantive and inclusive. The following steps and suggested probing questions provide guidance as you practice. It is important to be non-judgmental in your responses. Keep a “poker face,” and refrain from saying “right!” to the response you were expecting and hoping to hear. Your neutrality encourages participants to contribute their viewpoints, which is critical for constructing meaning together. So take your time, be sure to pause after questions and comments, and encourage participants to discuss and share ideas.

30 minutes



See **Getting Ready #7** and its sidebar for a more thorough discussion of why this particular activity was chosen. If you would like to use a different activity, refer to the “Principles of Learning Design” (in the [Front Matter](#)) to select, create, or revise an existing activity.



Hands-on: Cup & Card

The purpose of this activity is to create a shared experience that will invite participants to think about their learning beliefs, behaviors, & goals through this personal experience. This activity does not fully explore the physics concepts for complete understanding. Some participants are just fine with this, while others may feel dissatisfied. These various reactions lead to a rich discussion about whether learning was taking place, and if so, what was learned.

1. Introduce the concept of being a learner.

Tell participants that the interactive, hands-on activities in the *Reflecting on Practice* program are designed to place them in the role of the learner. Display and share the following information:

- a. The hands-on activities provide a shared experience for participants to think about learning and teaching.
- b. They should engage fully in the activity as a learner.
- c. If they have done the activity before, or have a deep understanding of the concept, remind them to give space for their colleagues to mess with the ideas. They can also encourage their colleagues to articulate the ideas and questions that emerge for them during the activity.
- d. Activities used in this program are not designed to be used “as is” with visitors to informal science learning environments. If interested, participants can design an appropriate variation of the activity to be used with visitors.

2. Advise them to pay attention to the learning experience.

Tell participants they will be given a challenge to explore a physics concept with their colleagues in small groups. As they participate, they should also pay attention to what is being learned, and how.

3. Display the instructions and challenge questions and demonstrate the steps without actually doing the activity.

Cup & Card Instructions

Fill containers with water from the dishpan and place a plastic card over the top. Invert each container and observe what happens.

Challenge questions:

1. Can you get the card to stay on the inverted cup?
2. Does the amount of water matter?
3. How does the shape of the cup affect the results?

4. Encourage exploration.

Encourage participants to explore using different amounts of water and differently shaped cups/containers. Ask them to learn all they can about the combination of cups, water, and card. Let them know they will have 20 minutes to investigate.

5. Start the Activity.

Distribute the dishpan of water and tray of materials to each small group and have them work, explore, and discuss what they discover in their small group.

6. Encourage discussion.

Circulating around the room, prompt group members to discuss their ideas, discoveries, and questions with each other.

Suggested prompts:

- ☐ Does it matter how much water is in the cup?
- ☐ How does the shape of the container affect the results?
- ☐ What generalizations can you make?

7. Introduce the Penny Challenge.

After participants have had an opportunity (~10 minutes) to explore various combinations of cups, water, and cards, distribute about 50 pennies to each group. Challenge each group to count how many pennies can be added to a cup with water before the card falls off when the cup is inverted. What do they notice?

Circulating around the room, ask some of the following guiding questions:

- ☐ How many pennies can you add? Who can add the most pennies?
- ☐ Is there a relationship between the containers' size/shape, amount of water, and number of pennies each will hold?
- ☐ Do you find anything puzzling about your discoveries?
- ☐ What does and does not make sense to you?

8. Wrap up the activity and clean up materials.

Have each group place all materials back on the tray and move the tray and dishpan to the side or back of the room.

9. Display prompts and debrief the activity in small groups.

Display the question prompts and ask participants to think silently for a moment to collect their thoughts about the learning experience that just occurred.



In the debrief of this activity, participants often become distracted by trying to explain the scientific phenomenon, rather than thinking about their learning beliefs, behaviors, and goals in the context of this experience. If the conversation gets diverted, challenge participants to think about their thinking process in the learning experience to consider what they learned and how they learned it.

Wait for participants to be ready to talk, especially the quieter ones, and stay neutral in your reaction to participants' comments.



When they are ready, have them talk in their small groups and address the following questions about the **Cup & Card** activity:

- a. What did you learn?
- b. How did you learn it?
- c. When did the learning occur?
- d. How did you know you were learning?

10. Connect back to ideas about learning.

Direct participants' attention to the previously discussed and recorded ideas about how to tell if someone is learning and how to support learning. (From **Turn & Talk**, step 5.) Encourage participants to make connections between ideas shared in the **Turn & Talk** discussion and their experiences during the **Cup & Card** activity.

11. Begin Whole-Group Share.

Encourage participants to share what they discussed in the small groups. Facilitate the discussion using the following steps:

- a. Invite and listen to their responses. Record ideas on the board as you facilitate the discussion.
- b. Encourage participants to elaborate on their thinking by providing explanations, evidence, or clarifications.

Suggested probing questions:

- ☐ What makes you think that?
- ☐ Please give an example from your experience.
- ☐ What do you mean?

- c. Draw others into the conversation by asking them to react and respond to what is shared. Ask for alternative viewpoints, agreements or disagreements.

Suggested probing questions:

- ☐ Can anyone add something to that comment?
- ☐ Who would like to share an alternative opinion?

- d. Display connecting questions to push on the group's thinking:

How do the “characteristics of learning” and “conditions that encourage and support learning” that we’ve discussed align with the learning goals for experiences at your institution? In informal environments in general?

- e. Based on interest, distribute the optional handout **Science Content for Cup & Card**.

Walkabout Research Discussion: *Five Foundational Ideas on Learning*

30 minutes



1. **Hang the five chart papers for the *Five Foundational Ideas on Learning*** around the room. (If wall space is limited, the charts can be placed on five different tables.)

2. **Introduce Research Discussion.**

Explain to participants that their personal and professional experiences are valuable sources of knowledge for understanding learning and teaching. This knowledge, however, may be limited to what they and their colleagues have personally experienced.

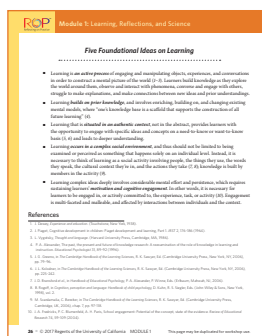
Research Discussions give them a chance to relate their experiences and thinking to ideas that have been reported in the literature. These may be results from empirical studies, conclusions from research projects and literature reviews, and/or statements from conceptual or theoretical papers. Explain that research discussions will challenge them to consider how key ideas from the literature might be used to inform their practice. They may agree or disagree with the ideas presented, have questions about the studies, or want more details. These reactions show they are thinking deeply about the ideas and are trying to reconcile the ideas with their own understanding and experiences. These debates are welcome, but the emphasis should be on digging into the ideas, what they mean, and how they can be used to inform their own practice, rather than on the nature of the sources.

3. **Introduce Walkabout Research Discussion Routine.**

Tell participants that throughout the *Reflecting on Practice* program they will have the opportunity to engage in research discussions in various ways. Today they will do the **Walkabout Research Discussion** routine. Describe the steps of the routine as follows:

- a. Five chart papers for the *Five Foundational Ideas on Learning* have been placed around the room. Each chart paper has one of the foundational ideas listed. More details about the idea are in the handout they will receive.
- b. They will work in small groups to consider and discuss each of the charts. They will have about 5 minutes at each of the charts.
- c. Each group will have a different-colored marker so that, as ideas from each group are mapped from chart to chart, different groups can compare their responses. Each group can decide whether everyone will take turns writing or if someone will be designated as a recorder.

See **Getting Ready #8** for a description of what to write on each chart.



Facilitators can be active participants to model how to respond, comment, question, and push.

- d. Once they are done discussing and recording ideas on one chart, they will rotate (“walkabout”) clockwise to read, think, talk, and connect ideas between charts and between groups, until they have visited each chart in turn.
4. **Display the three question prompts.**
Direct participants’ attention to the questions they will respond to at each chart. Leave these questions displayed throughout the task.
 - a. What ideas come to mind when you consider this idea?
 - b. What connections can you make to others’ responses?
 - c. What questions arise as you think about the ideas and consider the responses and comments of others?
 5. **Assign participants to groups and distribute *Five Foundational Ideas on Learning* handout:**
 - a. Divide participants into five groups (or fewer, if you have fewer than 10 participants), each stationed in front of one of the charts. Give each group a colored marker.
 - b. Distribute the *Five Foundational Ideas on Learning* handout.
 - c. Remind them to work with their small group to read, discuss, and then write on the chart paper with their assigned colored marker.
 - d. Explain that you will keep time and have them rotate (“walkabout”) clockwise to the next chart about every 5 minutes.
 6. **Make observations and guide responses.**
Circulate around the room as groups discuss each idea. Listen to what they say (and don’t say), and notice what they write. Guide them on the types of responses they can make as they read the ideas on the chart.

Suggested types of responses:

- ☐ Connect ideas between charts and between groups
- ☐ Elaborate on others’ ideas
- ☐ Comment on what others have written
- ☐ Ask others to respond with more details

7. Begin Whole-Group Share.

Once all the groups have rotated through all five ideas, have groups return to the chart paper they originally started with to read what others have written. Allow time for participants to review the chart, and then invite each group to share its thoughts, using the following displayed prompts. These are designed to encourage synthesis of ideas as you lead the whole-group discussion:

- ☐ What themes emerged?
- ☐ Were there common issues and reactions across the groups?
- ☐ What questions surprised them?

8. Facilitate group discussion.

As participants share their thinking, challenge them to elaborate on their ideas and encourage them to consider multiple viewpoints. Facilitate the discussion using the following steps:

- a. Invite and listen to their responses.
- b. Challenge participants to elaborate on their thinking by providing explanations, evidence, or clarifications.

Suggested probing questions:

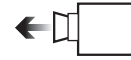
- ☐ What makes you think that?
- ☐ Please give an example from your experience.
- ☐ What do you mean?

- c. Encourage participants to provide alternative opinions or ideas, and 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?
- ☐ What do others think about that idea?
- ☐ Does anyone disagree with that comment?

- d. Call out trends and challenges that emerge.
- e. Summarize ideas shared.



Remember to stay neutral and pause after asking a question. Wait for multiple participants before selecting someone.

20 minutes



If different departments/teams of educators are participating together (e.g., youth programs, early childhood educators), it may be helpful to keep those groups intact for this task.

Session 1: Learning, Reflections, and Goals

Applying the Five Foundational Ideas

How do the programs you teach address each of the Five Foundational Ideas on Learning?

Foundational Idea	How my program addresses this idea:
Learning is an active process of engaging and constructing objects, experiences, and relationships in order to construct a mental picture of the world.	
Learning builds on prior knowledge and creates something new, and is shaped by existing mental models.	
Learning that is situated in an authentic context provides learners with the opportunity to engage with specific ideas and concepts and a need for understanding that leads to deeper understanding.	
Learning occurs in a complex social environment, and thus should not be assessed solely on an individual level.	
Learning requires that deeply learned, considered, revised, and sometimes which requires learning to be motivated and engaged.	

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5 minutes



Let's Talk Practice: Applying the Five Foundational Ideas

1. Introduce Let's Talk Practice.

Let participants know it's time to make connections and to deliberately apply these ideas to their practice. To do so, they will engage in a routine called **Let's Talk Practice**.

2. Form new groups.

Tell participants to form new groups of 3–4 people so there is a mix of people from each of the previous small groups.

3. Distribute Applying the Five Foundational Ideas handout to each participant.

Display the question prompt and have participants first work *individually* to fill in the worksheet, then share and revise based on discussion with their small group.

Question prompt:

- How do the programs you teach and/or design address the *Five Foundational Ideas on Learning*?

4. Conduct a quick share-out.

Invite groups to share big ideas, revelations, questions, and concerns that came up in their conversation, using the same facilitation techniques as for previous routines.

Closing Thoughts: Personal Goals for the Program

Tell participants that it's time for individual entries in their **Learning Journals**. Display the prompts and allow a few minutes for participants to gather their thoughts from this first session and then write plans for themselves.

Question prompts:

- What are your personal goals for participating in this professional learning program?
- Why are these particular goals personally or professionally important to you?
- How will you commit yourself to achieve these goals?

Continue the Learning

1. Discuss parameters and expectations for Continue the Learning tasks.

Based on your decision for assigning tasks outside of these interactive sessions, explain those expectations to the participants.

2. Suggested reading.

If you've decided to assign the reading, share that with participants now:

Surrounded by Science Chapter 1: "Informal Environments for Learning Science." (Title can be searched online at www.nap.edu/topic.)



5 minutes

About the Program: *Reflecting on Practice*™

Reflecting on Practice is a professional learning program designed for educators in informal science learning environments. It was developed at the Lawrence Hall of Science, University of California, Berkeley. The program immerses beginning and veteran educators in discussions about, reflections on, and application of research and theory on learning and teaching science. The goal of the program is to advance the informal science education field by cultivating communities of learners among its professionals; to that end, the program is facilitated by informal educators for colleagues in their own institutions.

The program has three key objectives:

- To build shared language and understanding among professionals by delving into the literature on learning and teaching.
- To engage practitioners in habits of reflection through observing their own teaching, as a means to develop their practice and make it public.
- To nurture a tradition of continued professional learning among participants, and thereby build a professional learning community.

Professional learning refers to practitioners' ongoing learning about their practice in order to increase their expertise and skills. It is valuable for improving practice regardless of profession. (Webster-Wright 2009)

Professional learning community is a group of practitioners who share and critically examine their practice in a way that is ongoing, reflective, collaborative, inclusive, learning-oriented, and growth-promoting. (Stoll et al., 2006)

Implementation

Educational staff at informal science learning environments of all types—museums, zoos, aquariums, interpretive centers, gardens, and other out-of-school learning settings—are encouraged to participate in the *Reflecting on Practice* program. The program is designed so that all educators at your institution (both veteran and beginning educators, paid or unpaid) can learn together and from one another. The institution adopts the program and implements it with its own staff facilitators, offering time and space for its education staff to participate.

Program facilitators are emerging leaders from your institution who have attended a *Reflecting on Practice* Coaching Workshop. In these workshops, facilitators become familiar with the philosophy and design of the program; learn its models of teaching practice and activities; and connect with other *Reflecting on Practice* facilitators in the region.

(continues)

About the Program: *Reflecting on Practice* (continued)

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Professional Recognition

Program participants can earn credits towards broader professional recognition in the field of informal science education. *Reflecting on Practice* is a Learning Partner with the **Association of Zoos and Aquariums (AZA)**, an approved continuing education provider for the **National Association for Interpretation (NAI)**, and a special partner with the **Association of Science-Technology Centers**.

Program Design Elements

Four key practice elements are intentionally designed into the program:

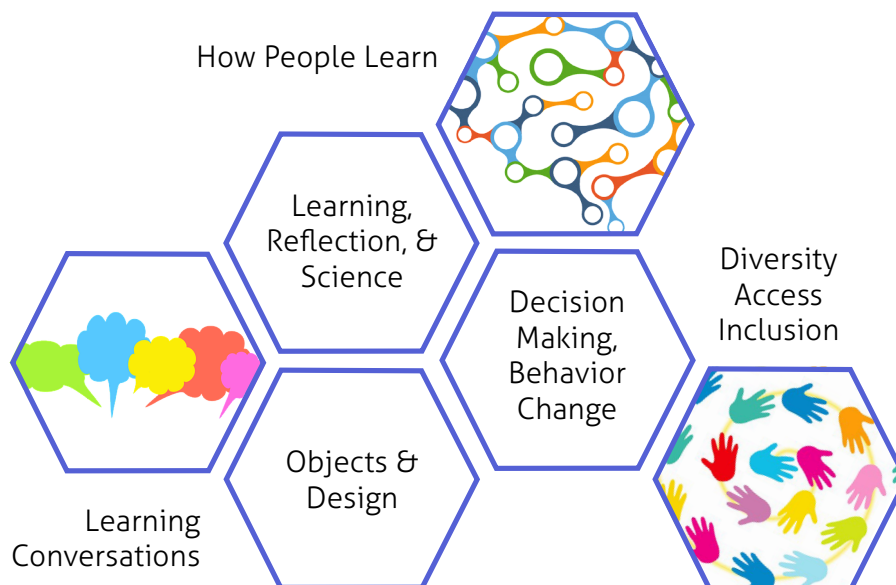
1. *Model and build practice* (e.g., **Hands-on: Cup & Card**). Facilitators lead interactive sessions in which they model evidence-based practice. Participants engage as active learners, as they discuss pedagogy and reflect on their own practice.
2. *Relate research to practice* (e.g., **Research Discussions**). To learn to implement research into their own teaching practice, as modeled by program facilitators, participants read and discuss key ideas from the literature. Research discussions provide participants with opportunity to talk with their colleagues about—and make sense of—ideas from research.
3. *Talk about and experiment with practice* (e.g., **Let's Talk Practice, Closing Thoughts**). Participants are given time to think about pedagogical strategies they currently use and to generate approaches they would like to try. They are encouraged to experiment with their teaching practice, and to share their experiences with one another.
4. *Observe and reflect on practice* (e.g., **Learning Journals, Video Reflections**). Participants engage in activities designed for reflection both individually, by videotaping their teaching, and as a community, making their practice public by reviewing those tapes with colleagues in a supportive learning community. Facilitators encourage participants to examine their teaching preferences, as well as to consider the approach and philosophy of their team, department, and institution.

(continues)

About the Program: *Reflecting on Practice* (continued)

Format, Content, and Shared Practice

Reflecting on Practice is a modular learning program. Each module focuses on topics relevant to educational practice in informal science learning environments. These include: the nature of learning and science; how people learn; learning conversations; objects and design; diversity, access and inclusion; and decision making and behavior change. Each module consists of 3–4 **interactive sessions**, and Module 2 onwards also incorporates discrete **Video Reflection** sessions (a hallmark of the *Reflecting on Practice* program), in which participants review and improve their practice together.



Interactive sessions are 2.5 hours long. Each module includes one interactive session for **core content** and another for **advanced study**. The sessions are designed to engage participants in activities and discussions on learning and teaching—both drawing on their personal and professional experiences and integrating research from the fields of neuroscience, psychology, education, and sociology. Participants are encouraged to candidly and safely express their beliefs and understanding, review their habits and assumptions, and determine how to apply research into their practice.

Video Reflection sessions are 2–2.5 hours long. Each module from 2 onwards includes one video reflection session for the whole participant community, and at least one other in which participants meet in small, critical-colleague groups. The *Reflecting on Practice* design uses research-based evidence on the effectiveness of such sharing of practice within a community. By using video clips of their real-world interactions to reflect on their practice and draw on facilitated observations and feedback from colleagues, participants experience profound change in their teaching habits and mindsets.

Science Content for Cup & Card (Optional)

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Optional additional information: the science behind Cup & Card

Note: The purpose of the Cup & Card activity is to promote discussion about learning and pedagogy. It is not intended to facilitate a complete understanding of the physics concepts or to provide a model activity to use with visitors. The additional information below is provided in the event you would like to know more about the physics concepts introduced.

If the cup is completely full of water

If the cup is completely full of water, there is essentially no air in the cup, and therefore no air pressure (a vacuum). Air pressure pushing on the card from outside the cup (atmospheric pressure, 14.7 lbs. per square inch) is therefore greater than the air pressure inside the cup. Only the outside air pressure is keeping the water in the cup.

If the cup is not totally full of water

When you invert the cup, some of the water drips out and the volume of the inside air pocket increases. However, since no more air can enter the cup, the air in the pocket spreads out to fill the available space. This causes the air pressure of the air pocket in the cup to decrease. The outside air (atmospheric) pressure is now greater than the inside air pressure, so once again the water stays in the cup.

If you are interested in even more details about the physics of the Penny Challenge part of the Cup & Card activity, read on...

To determine the maximum pressure that could be supported by the card for 200ml of water and the total number of pennies that can be added without the card falling off, use the following formulas:

$$P_T \text{ (total pressure)} = S \text{ (pressure from pennies + pressure from water)}$$

Pressure is determined by the amount of force per unit area:

$$P \text{ (pressure)} = F \text{ (force)} / A \text{ (area) so,}$$

$$P_T = \text{force from pennies/area of cup opening} + \text{force from water/area of cup opening}$$

The downward force of an object is determined by its mass and the acceleration due to gravity: $F = mg$
 ($g = 9.8 \text{ m/sec}^2$, the mass of one penny is 2.5 g, the mass of 1 ml water is 1g)

The area of a circle is $A = \pi r^2$

Total pressure supported by the card = _____

Five Foundational Ideas on Learning

- Learning is **an active process** of engaging and manipulating objects, experiences, and conversations in order to construct a mental picture of the world (1–3). Learners build knowledge as they explore the world around them, observe and interact with phenomena, converse and engage with others, struggle to make explanations, and make connections between new ideas and prior understandings.
- Learning **builds on prior knowledge**, and involves enriching, building on, and changing existing mental models, where “one’s knowledge base is a scaffold that supports the construction of all future learning” (4).
- Learning that is **situated in an authentic context**, not in the abstract, provides learners with the opportunity to engage with specific ideas and concepts on a need-to-know or want-to-know basis (5, 6) and leads to deeper understanding.
- Learning **occurs in a complex social environment**, and thus should not be limited to being examined or perceived as something that happens solely on an individual level. Instead, it is necessary to think of learning as a social activity involving people, the things they use, the words they speak, the cultural context they’re in, and the actions they take (7, 8); knowledge is built by members in the activity (9).
- Learning complex ideas deeply involves considerable mental effort and persistence, which requires sustaining learners’ **motivation and cognitive engagement**. In other words, it is necessary for learners to be engaged in, or actively committed to, the experience, task, or activity (10). Engagement is multi-faceted and malleable, and affected by interactions between individuals and the context.

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Applying the Five Foundational Ideas

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How do the programs you teach address each of the *Five Foundational Ideas on Learning*?

Foundational idea:	How my program addresses this idea:
Learning is <i>an active process</i> of engaging and manipulating objects, experiences, and conversations in order to construct a mental picture of the world.	
Learning <i>builds on prior knowledge</i> and involves enriching, building on, and changing existing mental models.	
Learning that is <i>situated in an authentic context</i> provides learners with the opportunity to engage with specific ideas and concepts on a need-(or want)-to-know basis, and leads to deeper understanding.	
Learning <i>occurs in a complex social environment</i> , and thus should not be perceived solely as something that happens on an individual level.	
Learning complex ideas deeply involves considerable mental effort and persistence, which requires sustaining learners' <i>motivation and cognitive engagement</i> .	