# BACKGROUND INFORMATION FOR PRESENTERS

**There has been much research, particularly in the past 15 years, concerning the processes involved in how people learn.** An awareness of some of the main findings from this research is useful to anyone involved in designing or presenting educational activities. This session is designed to open the door on the topic of how people learn, and suggest ways to craft learning experiences that reflect this understanding. It's clear from research that learning is not about passive transmission from instructor to student. If an instructor tells (or even chants or acts out) a piece of information, the information is not passed directly from the instructor's brain to the student's. The instructor must translate an idea into language, then the student interprets that communication. The student may then just memorize it, or actively compare or combine the new idea with their prior ideas. Our brains are designed to interpret new information based on previous experiences and ideas we've encountered. Ideas can be altered through this process. The understanding a student walks away with is not necessarily the same idea the instructor has presented, and may even be radically different or inaccurate. In order to create lasting conceptual understandings, students need active experiences, such as discussing with peers, interacting with the natural world, and testing their ideas and interpretations.

## The Learning Cycle

**The Learning Cycle model introduced in this session has been developed by researchers and educators and refined and deepened in recent years by newer findings in neuroscience and cognitive psychology.** The model is built upon what is known about how to support learning, and takes place in specific phases– invitation, exploration, concept invention, application, and reflection—which eventually lead the learner to begin the cycle once again. This model for instruction also takes into account the learner's prior understandings and recognizes their need for firsthand experiences. Lessons or activities designed according to the Learning Cycle are learner-centered, access and connect to learners' prior knowledge, provoke questions and explanations from the learners, provide opportunities for learners to talk about their ideas with peers and those with more knowledge, and consequently enable the learner to conceptually integrate and apply new ideas and information. All the learning activities in the BEETLES materials have been designed with the phases of the Learning Cycle in mind. Familiarity with this instructional model can help participants begin to understand how students can benefit from carefully designed activity plans, and supports the instructor's ability to make thoughtful instructional decisions while leading science activities.

While its roots go back to forerunners such as Dewey, Vygotsky, Bruner, Piaget, and others, the contemporary idea of the Learning Cycle grew out of a breakthrough in science education in the early 1960s, as scientists and educators wrestled with more effective ways to help students acquire, retain, and apply important concepts. In 1962 Robert Karplus and J. Myron Atkin described a three-phase cycle: exploration, invention, and discovery, termed the "guided discovery" approach to learning. The model was further developed in the 1970s as it was applied toward developing more effective science activities for the elementary classroom. The research on the effectiveness of the Learning Cycle has been quite extensive, (for a summary see Lawson, Abraham, & Renner, 1989; Lawson, 1995). The Learning Cycle has been instrumental in helping curriculum developers design materials and in assisting teachers in presenting educational experiences that are consistent with what is known about how people learn. Other learning cycle models have evolved including similar phases, although they may be named differently. Some of these instructional models maintain the three main stages of the Atkin/Karplus model, others involve four or more phases such as the 5 Es Model, which was developed by Roger Bybee in the 1980s (Bybee, Achieving Scientific Literacy, 1997). Some other variations on "learning cycles" include:

- 5 E's: Engagement, Exploration, Explanation, Elaboration, and Evaluation
- Flow Learning: Awaken Enthusiasm, Focus Attention, Direct Experience, Share Inspiration
- Coyote Mentoring Natural Cycle: Inspire, Activate, Focus, Take a Break, Gather and Share, Reflect, Integrate, Open and Close – Listen for What's Next
- Experiential Learning: Concrete experience, Reflective observation, Abstract conceptualization, and Active experimentation

**These learning cycle-based instructional models share a common vision of how learning takes place and are grounded in a constructivist theory of teaching and learning.** Constructivist ideas rely on the assumption that learners must internalize and transform information for themselves and with others in order to create deeper understandings. As summarized in the National Research Council's 2000 report *How People Learn: Brain, Mind, Experience, and School,* the most recent cognitive research supports the view that learners are active agents in their own construction of knowledge and delineates three key findings that relate closely to phases of the Learning Cycle.

- **Key Finding #1 states,"Students come to the classroom with preconceptions about how the world works. If their initial understanding is not engaged, they may fail to grasp the new concepts and information, or they may learn them for purposes of a test but revert to their preconceptions outside the classroom."** This finding explains why the Invitation phase of the Learning Cycle is so crucial and why teachers should take the time to uncover and try to understand students' prior knowledge of a subject before beginning an instructional sequence. The Invitation phase often provides a significant motivating factor for learning science by engendering student interest and generating a need to know and understand. Learning builds on prior knowledge, and involves enriching, building on, and changing existing understanding, where prior knowledge is "a scaffold that supports the construction of all future learning." Prior knowledge and experiences direct how new information and knowledge is processed and organized in working memory. If prior knowledge is organized poorly or ineffectively, new information may or may not fit. This situation, in turn, also strains working memory to process and organize new information into existing mental models.
- **Key Finding #2 states, "To develop competence in an area of inquiry, students must (a) have a deep foundation of factual knowledge, (b) understand facts and ideas in the context of a conceptual framework, and (c) organize knowledge in ways that facilitate retrieval and application."** This finding highlights the importance of the Exploration, Concept Invention, and Application phases of the Learning Cycle. Students should have a variety of opportunities to explore various scientific phenomena and data sets to acquire factual knowledge, and must also consider how this new information fits into larger conceptual frameworks. In this way, the knowledge of facts and an understanding of overarching conceptual ideas both play a significant role in helping students learn about science. Students also need multiple opportunities to apply what they've learned and "test out" their new conceptual frameworks in different situations. According to current research, the ability to easily access and transfer knowledge and understanding is key to developing expert knowledge in a discipline.
- **Key Finding #3 states: "A metacognitive approach to instruction can help students learn to take control of their own learning by defining learning goals and monitoring their progress in achieving them."** Meta-cognition involves learners in considering their learning path and taking note of experiences and ideas that have led to their personal understanding. This type of internal self-monitoring exemplifies the Reflection phase. As students acquire scientific knowledge and understandings, it's critical that they spend time discussing how they arrived at these concepts and explain their thinking. Through reflecting on their learning processes, they develop the ability to think flexibly and acquire new understanding as needed.

**It's important to be mindful of the fact that the Learning Cycle we present is one model that can be used to represent, organize, and categorize main phases that support learning.** It's not the only way to conceptualize learning. It should not be seen as a rigid or mechanical model—people and their learning processes are gloriously complex, and there is no automatic order or sequence in which these phases must take place. That said, the Learning Cycle model of instruction can be powerful and enormously helpful in stimulating thinking about how people learn and in designing lessons that succeed in conveying concepts to students in meaningful and effective ways.

**Sometimes, the Learning Cycle model is conflated with Howard Gardner's work on Multiple Intelligences or other writing about learning styles.** Research on learning styles shows that different individuals often have different preferences for teaching approaches. These preferences may have to do with identified learning styles or with their exposure to various teaching approaches in the past. Formerly, it was thought that one's preferred learning style(s) was the primary way one could learn. However, the latest research on cognition synthesized by Reiner and Willinghelm (2010) has not supported the idea that individual learners learn better from a particular style of teaching. Their findings support the idea that everyone learns through a variety of different teaching approaches, despite their preference or learning style. Instead, the research suggests that learners learn best through the opportunity to engage with the material through multiple modalities—reading, writing, talking, doing, etc., structured within the Learning Cycle instructional model.

## The Learning Cycle and this Session

**Of course, this professional learning session was also designed with the learning cycle in mind:**

- **Invitation**: An initial question was posed at the beginning of the session, "How can we use what we know about how people learn to create effective learning experiences?" Participants experienced the Freddy Fungus/Alice Algae story, and discussed the pros and cons of that approach for learners. Participants accessed their prior knowledge as they discussed and shared an example of when they learned something well, and what made it an effective experience
- **Exploration**: In small groups, participants struggled with how to sequence a series of steps of a lichen activity, while discussing the reasoning for their sequence.
- **Concept Invention**: Each team read about and then in the whole group explained the phases of the learning cycle, then discussed which steps of the lichen activity might match up with the goals of their assigned phase. Then the instructor added more information about the learning cycle model.
- **Application**: Participants experienced a model learning cycle-based student activity. The group discussed how the learning cycle applies to the structure of the student model activity and the whole session. Groups came up with plans for short learning cycle-based experiences.
- **Reflection**: Participants spend time thinking quietly, discussing with a partner and writing about their thoughts on the learning cycle, and describe specific things they can do to make their instruction more learning cycle-based.

## Experimenting with Extremes (a Lichen example)

**While experimenting with how withholding information might increase curiosity, one field instructor testing BEETLES approaches took it to an extreme.** She played up the engagement factor by—over a full week—never actually telling students the formal definition of lichen. She reported, "Those kids were on the edge of their seats by the end of the week, after we'd noticed, wondered, built new frames of reference, and pieced together evidence for what it reminded us of, as to what the green lacy stuff on twigs really was. Never have I had children so excited about lichen and figuring out what it was!" She also told us that she even succeeded in helping the same group of students invent the concept of a mutualistic organism—still without telling them what lichen is.

**In contrast, another field instructor, who was intrigued by and knowledgeable about lichen herself, told students information about lichen and even created a special lichen "museum" for them to look at on the trail, with different species, names, and information on index cards.** It was *all* concept delivery. Without an invitation and an opportunity for her students to explore before introducing content, they never became truly interested in the organism or the related information. The approach she used did not follow the Learning Cycle. Adding invitation, exploration, application, and reflection stages could have made the lesson into a much more meaningful experience for her students.

## Leading Discussions

**This session includes a significant amount of discussion and discussion leading.** We recommend that leaders review the background section of the *Promoting Discussion* session and the *Tips for Promoting Discussion* handout (which, although designed for instructors leading discussions with students, is also useful for those leading discussions with other adults). Instructors implementing the Learning Cycle might also be challenged by the significant amount of discussion involved. Setting up discussion norms both within a staff and a group of students is critically important to having good discussions. This session includes a quick conversation around five discussion norms that research shows are useful to create a culture of discussion (Michael & O'Connor, 2012). If your instructors don't have much experience with introducing discussion norms to students, consider spending more time with this part of the session and model one way these norms might be introduced to students. One suggestion is to have the group sit in a circle on the floor, and read aloud each norm, followed by quickly acting how what that looks like and the opposite of what it looks like. You can also share examples of how to disagree productively, ask people for evidence, or change your mind.