Examining the Learning Cycle

By Patrick L. Brown and Sandra K. Abell

"I use hands-on activities with my fifth graders as often as possible. But I worry that my students won't learn science just by doing activities. Is there a way to structure science lessons to go beyond the hands-on component?"

Is hands-on alone enough to learn science?

Jerome Bruner (1960) introduced the idea of "discovery learning," where students interact with their environment to discover new ideas. However, teachers who have tried to help students "discover" science ideas by doing hands-on activities often are frustrated when students do not learn what the teacher expected. Why should we expect our students to "discover" ideas that took science hundreds of years to invent? Maybe something is missing from the discovery approach.

Kathy Roth (1989) compared different approaches to teaching science concepts like photosynthesis to fifth graders. She found that students understood the science concepts better when hands-on activities were followed by student discussion and writing and when the teacher introduced ideas that challenged student misconceptions. Magnusson and Palinscar (2005) described a fourth-grade science class in which students investigated light and then attempted to explain its properties through dialogue with the teacher. In each of these cases, hands-on was necessary but not sufficient to help students learn science. *How can teachers structure science lessons to go beyond a hands-on activity?*

What is the learning cycle?

Roth, Driver, Magnusson, and Palinscar all employed a learning cycle approach to help students learn science. First fully described in 1967 by Karplus and Thier for SCIS, the *Science Curriculum Improvement Study*, the learning cycle is based on three phases of instruction: 1) *exploration*, which provides students with firsthand experiences to investigate science phenomena; 2) *concept introduction*, which allows students to build science ideas through interaction with peers, texts, and teachers; and (3) *concept application*, which asks students to use these science ideas to solve new problems. This teaching and learning cycle alternates between hands-on and minds-on activities, both of which are necessary for learning science.

Why is a learning cycle needed?

Cognitive scientists tell us that students need to relate new ideas to their experience and place new ideas into a framework for understanding (Bransford, Brown, and Cocking 2001). Thus exploring phenomena before explaining them is critical for learning. Researchers have found that students benefit when all three phases of the learning cycle are present (Renner, Abraham, and Birnie 1988). Abraham and Renner (1986) investigated whether the three stages of the learning cycle are in their optimal sequence. Trying various sequences in several high school science classes, they found that when *concept introduction* followed *exploration*, students learned better. The introduction of terms after investigations helps students connect new concepts with prior experiences. However, multiple experiences may be required. In a study of upper elementary students, Nuthall (1999) found that students needed three to four experiences with new science ideas before they were able to commit these ideas to long-term memory.

Since Karplus and Thier introduced the learning cycle, several variations have been invented. However, each new version retains the essence of the original learning cycle—exploration before concept introduction. One popular contemporary learning cycle is the 5-E model—Engage, Explore, Explain, Elaborate, Evaluate (Bybee 1997). It incorporates the three core learning cycle phases while adding Engage and Evaluate to facilitate what Roth (1989) would call conceptual change. The Engage phase of the 5-E is designed to captivate student attention and uncover student current knowledge. The Evaluate phase is a chance for the teacher to assess student progress and for students to reflect on their new understandings.

How does the learning cycle affect students?

Several studies have examined the learning that results from cyclic approaches to science instruction. Renner,

Abraham, and Birnie (1988) found greater achievement and retention when concepts were introduced after experiences. Gerber, Cavallo, and Marek (2001) found that students taught via a learning cycle scored higher on a test of scientific reasoning. Beeth and Hewson (1999) studied one teacher's science instruction in grades 4–6. She alternated hands-on activities with goal-directed discussion; her students improved their science understanding as well as their engagement in scientific discourse. Thus, a learning cycle approach helps students make sense of scientific ideas, improve their scientific reasoning, and increase their engagement in science class.

What can teachers do to change to learning cycle instruction?

If your science curriculum is dominated by a textbook, the first step in developing a learning cycle approach is to put the activities first (*exploration*). When students read the chapter (*concept introduction*) after the activity, they will have an experience to which to link the chapter ideas. You can find many ideas for employing learning cycles to teach particular science concepts in NSTA journals (for example, Cavallo 2001; 2005; McNall and Bell 2004). Once you have mastered designing a few lessons where explanations follow explorations, you will be ready to invent learning cycles for all of your science units. Books like Abell and Volkmann (2006) demonstrate how learning cycles can work across the elementary grades and across the science curriculum.

Patrick L. Brown is a former high school biology teacher and current doctoral student in science education at the University of Missouri–Columbia. Sandra K. Abell* (AbellS@missouri.edu) *is Curators' Professor of Science Education at the University of Missouri–Columbia (MU) where she directs the MU Science Education Center.

References

Abell, S.K., and M.J. Volkmann. 2006. *Seamless assessment in science: A guide for elementary and middle school teachers*. Portsmouth, NH: Heinemann.

Abraham, M.R., and J.W. Renner. 1986. The sequence of learning cycle activities in high school chemistry. *Journal of Research in Science Teaching* 23(2): 121–143.

Beeth, M.E., and P.W. Hewson. 1999. Learning goals in exemplary science teacher's practice: Cognitive and social factors in teaching for conceptual change. *Science Education* 83(6): 738–760.

Bransford, J., A. Brown, and R. Cocking. 2001. *How people learn: Brain, mind, experience, and school*. Washington, DC: National Academy Press.

Bruner, J. 1960. *The process of education*. Cambridge, MA: Harvard University Press.

Bybee, R.W. 1997. *Achieving scientific literacy: From purposes to practices*. Portsmouth, NH: Heinemann.

Cavallo, A. 2001. Convection connections. *Science and Children* 38(8): 20–25.

Cavallo, A. 2005. Cycling through plants. *Science and Children* 42(7): 22–27.

Gerber, B.L., A.M.L. Cavallo, and E.A. Marek. 2001. Relationship among informal learning environments, teaching procedures, and scientific reasoning abilities. *International Journal of Science Education* 23(5): 535–549.

Karplus, R., and H.D. Thier. 1967. *A new look at elementary school science*. Chicago: Rand McNally.

Magnusson, S.J., and A.S. Palinscar. 2005. Teaching to promote the development of scientific knowledge and reasoning about light at the elementary school level. In *How students learn: Science in the classroom*, eds. M.S. Donovan and J.D. Bransford, 421–474. Washington, DC: National Academies Press.

McNall, R.L., and R.L. Bell. 2004. Discovering flowers in a new light. *Science and Children* 41(4): 36–39.

Nuthall, G. 1999. The way students learn: Acquiring knowledge from an integrated science and social studies unit. *The Elementary School Journal* 99(4): 303–341.

Renner, J.W., M.R. Abraham, and H.H. Birnie. 1988. The necessity of each phase of the learning cycle in teaching high school physics. *Journal of Research in Science Teaching* 25(1): 39–58.

Roth, K.J. 1989. Science education: It's not enough to "do" or "relate." *American Educator* 13(4): 46–48.