How Students Learn

"While it is not new to include thinking, problem solving, and reasoning in some students' school curriculum, it is new to include it in everyone's curriculum."

Lauren and Daniel Resnick

Learning and Transfer

In the context of education, transfer is "the ability to extend what has been learned in one context to new contexts."[1] Learning anything is of limited value if it cannot be transferred into a useful, meaningful context.

The following are major factors influencing transfer:

- ***Mastery of the content:*** In studies of whether knowledge of computer languages transfers to other areas of thinking and problem solving, findings show that the more that is learned about a subject, the more likely it is to be transferred into other contexts.[2]
- ***Understanding versus memorizing:*** Students who only memorize facts have little basis for approaching problems with sound reasoning. For instance, students who have only been instructed to memorize the physical properties of veins and arteries have difficulty answering questions about how structure relates to function, such as "Why are arteries elastic?"[3]
- ***Learning time:*** Students need to be given sufficient time to learn concepts and process new information. Third graders typically take about 15 seconds to integrate pictorial and verbal information. When given only 8 seconds, mental integration does not occur.[4] Learning can't be rushed, nor should it move too slowly. When activities are stretched out for a long period of time, engagement often gives way to boredom.
- ***Motivation to learn:*** People are motivated to solve problems and achieve competence.[5] Rewards and punishments affect behavior, but people work hard for intrinsic reasons as well.[6] Students of all ages are more motivated when they can see the usefulness of what they are learning, particularly when they believe it will affect others in their community. When asked to name highlights of the previous school year, a group of inner-city sixth graders frequently mentioned projects that involved hard work but had strong social consequences, such as tutoring younger children or designing blueprints for playhouses.[7]
- ***Real-world relevance:*** Skills and knowledge must be extended beyond the narrow scope in which they are learned. Knowing how to solve a math problem in school may not transfer to solving math problems in other situations. A group of homemakers did very well at making supermarket best-buy calculations despite doing poorly on equivalent school-like paper-and-pencil math problems.[8] In a separate study, Brazilian street children performed math when making sales on the street, but they couldn't solve similar problems presented in a school context.[9]
- ***Prior understanding:*** Even on the first day of class, students bring relevant knowledge of the subject matter; however, they may have difficulty with teaching that conflicts with that knowledge. For example, students bring basic knowledge of the human and animal need for food to biology class.

> When studying the role of soil and photosynthesis in plant growth, some students have misconceptions such as soil is the plant's food, plants get food from their roots and store it in their leaves, or chlorophyll is the plant's blood. If the teacher does not take these misconceptions into account, address them, and discuss why they are incorrect, students can be easily left with an incorrect understanding.[10]

For learning to be truly effective, students must develop a sense of when their knowledge can be used. Failure to learn something often occurs because students have little or no idea when they are supposed to use the knowledge they have been taught. For example, if a math student sees no relevance to negative integers and has no understanding of how they might apply to anything outside math class, learning may occur at some level, but transfer most likely will not.

The knowledge needed for good thinking is acquired only through the processes of thinking. Knowledge must be used generatively—it needs to be called up again and again to link to, interpret, and explain new information.[11]

Adapted from J. D. Bransford, A. L. Brown, and R. R. Cocking, *How People Learn: Brain, Mind, Experience, and School,* National Academy Press, Washington, DC, 1999.

Endnotes

1. J. P. Byrnes, *Cognitive Development and Learning in Instructional Contexts,* Allyn and Bacon, Boston, MA, 1996.
2. D. Klahr and S. M. Carver, "Cognitive Objectives in a LOGO Debugging Curriculum: Instruction, Learning, and Transfer," *Cognitive Psychology 20*(3), pp. 362-404, 1988; and J. Littlefield, V. Delclos, S. Lever, K. Clayton, J. Bransford, and J. Franks, "Learning LOGO: Method of Teaching, Transfer of General Skills, and Attitudes Toward School and Computers," in R. E. Mayer (Ed.), *Teaching and Learning Computer Programming,* Erlbaum, Hillsdale, NJ, 1988.
3. J. D. Bransford, B. S. Stein, N. J. Vye, J. J. Franks, P. M. Auble, K. J. Mezynski, and G. A. Perfetto, "Differences in Approaches to Learning: An Overview," *Journal of Experimental Psychology: General, 3,* pp. 390-398, 1983; and J. M. Bransford and B. S. Stein, *The IDEAL Problem Solver* (2nd ed.), Freeman, New York, 1993.
4. K. Pezdek and L. Miceli, "Lifespan Differences in Memory Integration as a Function of Processing Time," *Developmental Psychology, 18,* pp. 485-490, May, 1982.
5. R. W. White, "Motivation Reconsidered: The Concept of Competence," *Psychological Review, 66,* pp. 297-333, 1959.
6. M. Csikszentmihalyi, *Creativity: Flow and the Psychology of Discovery and Invention,* Harper Collins, New York, 1997.
7. B. J. Barron, D. L. Schwartz, N. J. Vye, A. Moore, A. Petrosino, L. Zech, J. D. Bransford, and Cognition and Technology Group at Vanderbilt University, "Doing With Understanding: Lessons from Research on Problem and Project-Based Learning," *Journal of Learning Sciences, 7*(3-4), pp. 271-311, 1998.
8. J. Lave, *Cognition in Practice: Mind, Mathematics, and Culture in Everyday Life,* Cambridge University Press, Cambridge, MA, 1988.
9. T. N. Carraher, D. W. Carraher, and A. D. Schliemann, "Mathematics in the Street and in School," *British Journal of Developmental Psychology 3,* pp. 21-29, 1985.
10. J. P. Mestre, "Cognitive Aspects of Learning and Teaching Science," in S. J. Fitzsimmons and L. C. Kerpelman (Eds.), *Teacher Enhancement for Elementary and Secondary Science and Mathematics: Status, Issues, and Problems,* National Science Foundation, Arlington, VA, 1994.
11. L. Resnick and D. Resnick, "Assessing the Thinking Curriculum: New Tools for Educational Reform," pp. 37-75, in B. Gifford and M. O'Connor (Eds.), *Changing Assessments: Alternative Views of Aptitude, Achievement and Instruction,* Kluwer Academic Publishers, Boston, MA, 1992.

NCREL

This work was produced in whole or in part with funds from the U.S. Department of Education under Eisenhower grant number R168R50003. The content does not necessarily reflect the position or policy of the Department of Education, nor does mention or visual representation of trade names, commercial products, or organizations imply endorsement by the federal government.