HOW STUDENTS LEARN

The last decade has brought significant advances in scientific research on intellectual development. We know more about the human mind and brain than ever before, yet the research has had seemingly little impact on how schools educate children. Knowledge of how the brain works and develops is only relevant to education if the information is used to improve education.

What does the research tell us about how students learn? How can schools use this information to do better? Are there more efficient ways to teach students what they need to know? How do we provide them with more effective intellectual tools and learning strategies they will need after leaving the classroom?

School Versus Life

The ultimate goal of schooling is to prepare students for life beyond graduation—higher education and the workplace. However, the environment created by the culture of our schools may be compromising that goal by starkly contradicting the environment outside of school.

In the book *How People Learn: Brain, Mind, Experience, and School (1999)*, John Bransford, Ann Brown, and Rodney Cocking summarize modern research into learning and the role of schools. The book presents three major discrepancies between the culture that dominates schools and that of today's workplace:

- Individual work and achievement is stressed at school, while in the workplace, it is rare that individuals succeed without collaboration from others. For instance, no individual alone can pilot a ship,[1] make significant scientific discoveries in a genetics laboratory,[2] or make critical decisions in a hospital emergency room.[3] These, and most other professions, require teamwork, input and cooperation from a number of people, efficient communication, and coordination of knowledge and effort.

- In the workplace, tools are used to solve problems and get work done faster, more efficiently, and more conveniently. School emphasizes "mental work." People in the workplace can work efficiently and almost error-free with the use of tools such as calculators, computers, and software.[4] New technologies have made it possible for students in school to use those same tools, but they don't.

- School emphasizes abstract reasoning while the real world presents contextual situations.[5] Reasoning can be improved when abstract problems are applied in a context that means something to students.[6] Consider the example set by problem-based learning in medical schools. The opportunity for first-year medical students to engage in actual case-based problem solving leads to a greater ability to diagnose and understand medical problems than do opportunities to learn in a typical lecture-based medical course.[7]

Understanding Learning

School, particularly in mathematics, typically stresses repetition and practice.[8] As John Dewey pointed out, the culture of schools fails to emulate that of the workplace, even though it should.

To give students a school environment that more effectively prepares them for life beyond the classroom, the current environment must be reexamined and changed. To do so, it is important for educators to better understand thinking, learning, and teaching, as well as the demands of today's society and the needs of tomorrow's leaders.

These issues are summarized in separate Fact Sheets, under the following titles:

Experts and Novices

Learning and Transfer

Children as Students

The Mind and Brain

Changing Needs, Changing Goals

Schools have been teaching the same basic skills for decades, even as the world around them has changed drastically. Reform efforts have focused on teaching reading, writing, and arithmetic more efficiently; however, it is no longer enough. Education now must do more.

In the last 30 years alone, computers have altered society and the workplace in ways no one could have foreseen. Skill sets for meaningful, productive careers demand more than just factual knowledge—more than just reading, writing, and calculating. Information management and problem solving are critical skills necessary for survival in today's workplace. Knowledge of mathematical equations, scientific formulas, and definitions is not nearly as useful as attaining an understanding of math and science concepts and the ability to frame and ask questions about them.

School traditionally has been a place for students to acquire knowledge. With the rapid growth of the Internet, the amount of knowledge and information available today is staggering. No significant portion can be learned or taught. In the 21st century, students will be better served if school is a place where they can be taught to manage information, acquire what is relevant, and apply it to solve problems. For teachers, this goal is practical and entirely achievable.

Endnotes

1. L. B. Resnick, *Education and Learning to Think,* National Academy Press, Washington, DC, 1987.

2. K. Dunbar, "Problem Solving Among Geneticists," Paper prepared for the Committee on Developments in the Science of Learning for the "Sciences of Science Learning: An Interdisciplinary Discussion," 1996.

3. V. L. Patel, D. R. Kaufman, and S. A. Magder, "The Acquisition of Medical Expertise in Complex Dynamic Environments," in K. A. Ericsson (Ed.), *The Road to Excellence: The Acquisition of Expert Performance in the Arts and Sciences, Sports and Games,* Erlbaum, Mahwah, NJ, 1996.

4. P. Cohen, *A Calculating People: The Spread of Numeracy in Early America,* University of Chicago Press, Chicago, 1983; A. D. Schliemann and N. M. Acioly, "Mathematical Knowledge Developed at Work: The Contribution of Practice Versus the Contribution of Schooling," *Cognition and Instruction,* 6, pp.185-222, 1989; H. A. Simon, "On the Development of the Processes," in L. B. Resnick and L. E. Klopfer (Eds.), *Information Processing in Children,* ASCD Books, Alexandria, VA, 1972; D. A. Norman, *Things That Make Us Smart: Defending Human Attributes in the Age of the Machine,* Addison-Wesley, New York, 1993.

5. Resnick, 1987.

6. P. C. Wason and P. N. Johnson-Laird, *Psychology of Reasoning: Structure and Content,* Harvard University Press, Cambridge, MA, 1972.

7. C. E. Hmelo, "Problem-based Learning: Development of Knowledge and Reasoning Strategies," in *Proceedings of the Seventeenth Annual Conference of the Cognitive Science Society,* Erlbaum, Pittsburgh, PA, 1995.

8. See "The Classroom: Homework" and "The Classroom: Classwork."

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