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The Fundamental Importance of the Brain and Learning for Education

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People learn. Learning is fundamental to us as human beings. It is the specialization that we use to become fully human. A major part of that specialization is our exceptionally large brain, which is the primary organ for learning. We spend the many years of childhood learning the extensive knowledge of our cultures and families. In complex modern cultures, we have created schools as the main institution for promoting learning beyond the family. Modern culture requires that we learn so much, spending years going to school to learn the special tools and skills of literacy, mathematics, history, science, art, music.... That means that schools and the brain belong together, joined by the common purpose of learning (Battro et al., 2007).

The Biological Revolution and Education

There is a revolution afoot that is bringing brain and cognitive science into education and that will create new tools to vastly improve how students learn. Or is there? Expectations for educational neuroscience are extremely high, but at this point it could turn out to be just another fad, a popular enthusiasm that fades with time as the unreality of exaggerated expectations becomes clear (Bruer, Chapter 5 in this book). What is needed is not a quick fix from neuroscience – which will not work for education

– but instead the creation of a new field that integrates neuroscience and other parts of biology and cognitive science with education (Immordino-Yang, 2007; Szucs & Goswami, 2007). Creating this field, which some of us call *mind, brain, and education* (Fischer et al., 2007b), can in the long term transform schools and education by creating a scientific basis for educational practice.

This is a new era in science and education – a time when biology is the leader of the sciences, when new discoveries about the brain, genes, and the processes of life make headlines every day. In the popular media we see amazing pictures of what happens in the brain, how it changes in positive and negative ways – such as learning to read and becoming addicted to a drug. These advances in tools for imaging the brain promise to improve education: showing how learning occurs, how a math class can change neural networks, how different languages can shape perception and memory in the brain, how fundamentally emotions shape our thinking, learning, and beliefs.

In the midst of all the new science, the deep need for extending and improving education is clear, for North America and for the world. Education has proven to be one of the best ways of improving people's lives, leading them not only to better jobs, but to better health for themselves and their children and to greater prosperity for their community and nation (Graham, 2005). Schooling has proven to be the best single way not only to promote learning to read but also to stimulate economic growth, to improve the health of infants and their mothers, and to reduce the birth rate and prevent overpopulation. With such great needs and hopes, the expectations for schools and other forms of education have surged to extremes, often extending beyond what could actually be possible. These high expectations are coming together with the advances in

brain science and related disciplines, leading to hopes that science will bring about fast advances in educational practice.

The potentials of brain science for education are indeed enormous. But realizing them requires building a new interdisciplinary science that explicitly links brain science and education in a collaboration, with both playing strong roles. For this interdisciplinary approach to prosper in a way that moves beyond a transient fad, educators need to know about brain science, and scientists need to know about education. Using scientific research to answer questions about education requires that educators and scientists work together to ask useful questions and ultimately to build *usable knowledge* that will inform educational practice, illuminating how learning occurs in schools and other educational settings.

To many people, educational implications seem like a natural extension of neuroscientific research. After all, when we educate children, we are shaping the ways that their brains and minds develop and learn. Unfortunately, most of what is called “brain-based education” today has no grounding at all in brain or cognitive science. The only way that brains are involved in most brain-based education is that the students have brains. In typical claims for brain-based education, beliefs about learning and schooling are restated in the language of brain science, but there is no brain research on which those restatements are based. Brain science is still a young field, not a mature science, and educational neuroscience is even younger, with only a small number of studies examining brain processes for learning in educational settings. Even if claims for brain-based education ultimately prove to be true, there is currently no scientific basis for most of them, because the research has not yet been done.

The good news is that the first glimmers of educational neuroscientific research are highly promising. For example, early research on reading difficulties such as dyslexia uses brain imaging to test how students learn to read and what methods can improve their learning (Szucs & Goswami, 2007; Part IV? in this book). Research on brain and cognitive processes in development and learning suggests new tools for assessing learning – tools that promise powerful ways of tracking how individual students learn effectively as they move along specific learning pathways, which often differ across people and topics (Bransford & Donovan, 2005; Fischer & Bidell, 2006). Research on how children learn with distinctly different brains suggests a remarkable flexibility in the ways that people adapt their abilities to learn important skills such as emotional communication in language (Immordino-Yang, 2007; Part VI? in this book). These and many other research questions can eventually produce major improvements in education. Many young educators and scientists are entering this emerging field to create these improvements, and a few training programs have recently been established, such as the program in Mind, Brain, and Education that we began at Harvard in 2000 (http://gseweb.harvard.edu/~mbe) and the new program in Neuroscience and Psychology in Education at the University of Cambridge in England (http://www.educ.cam.ac.uk/randd/npe.html).

Yet there will be no quick fix from educational neuroscience. Building a new field takes time – to bring together educators and brain scientists to figure out how learning occurs effectively in educational settings, to formulate questions that will be useful for improving educational practice, to study how students learn effectively and ineffectively. If neuroscience can help inform the education process, then it would seem important

that teachers and others in educational roles know something about the brain and learning. This book makes small steps toward this goal, helping educators begin to form a foundation of knowledge about brain and cognitive science as it relates to education.

Using This Book

This book can play an important role in creating the new field – helping the new generation of educators (including you!) to learn about brain and cognitive science so that they can shape effective questions and build a research base to improve education. The book can be an excellent teaching tool for educators and teachers in training. It includes readings from many of the foremost thinkers in the field of cognitive neuroscience, as well as interpretive and summarizing readings by master educators. The main strength of this volume lies in bringing together readings by diverse scientific researchers that have the potential to inform learning and education when taken together. To our knowledge, this volume is the first to bring such writings together in one place.

There are sections introducing the brain and neuroscience, the debate about brain-based learning and the nature of intelligence, and work about traditional academic skills, such as reading and mathematics. The book goes beyond those obvious choices to connect neuroscience to other essential components of an education – the arts, emotion, social functioning, and exceptional and atypical thinkers. Too often discussions of neuroscience and learning follow the unfortunate lead of much of education, heavily emphasizing traditional skills and omitting or neglecting other important areas involved in being a person. Learning about emotions, the arts, social interaction, and exceptional learners provides the perspective of the whole person, including the ways that

neuropsychological strengths and weaknesses interact in brain and behavior (Fischer et al., 2007a). The design of effective learning environments requires breaking down the artificial disciplinary boundaries of traditional educational approaches and considering both the whole person and relations between the specific skills that are so important for education, such as literacy and mathematics.

One of the lessons of educational neuroscience, even at this early point in its development, is that children learn along specific pathways, but they do not act or think in compartments (Fischer & Bidell, 2006; many chapters in this book). On the one hand, they develop their learning along specific pathways defined by particular content, such as mathematics or history, but on the other hand they also form connections between those pathways. Indeed, reading is a perfect example, requiring the integration of the separate domains of visual analysis (written words), sound analysis (spoken words), and meaning. Reading also connects children's interests with their literacy skills, because it is such a powerful tool for learning about topics of interest. Indeed, many children learn to read because of a personal passionate interest: They are driven to read to find out more about animals or lawn mowers or the Civil War (Fischer & Fusaro, 2007). Ultimately, to become an educated person and an effective citizen, students need to learn a wide range of skills, built on an educational environment that their teachers and parents carefully construct to foster learning, motivation, personal responsibility, and creativity.

The brain is obviously the central organ for learning, and scientific research on learning and the brain promises many important new insights and tools that will improve

education around the world. But educational neuroscience is young – just emerging as a field in its own right. It does not offer quick and easy solutions to the tough problems of education. Its contributions to education will come in the long term, as educators and scientists work together to create the new science of learning and the brain.

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