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INTRODUCTION:
THE FUNDAMENTAL IMPORTANCE
OF THE BRAIN AND LEARNING
FOR EDUCATION

People learn. Learning is fundamental to human beings. It is the specialization that we use to become fully human. A major part of that specialization is our exceptionally large brain, 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 spend years going to school to learn the special tools and skills of literacy, mathematics, history, science, art, music, and much more. That means that schools and the brain belong together, joined by the common purpose of learning (Battro, Fischer, & Lena, 2007).

The Biological Revolution and Education

There is a revolution afoot that is bringing brain and cognitive science into education and creating 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 not a revolution but just another fad, a popular enthusiasm that fades with time as the unreality of exaggerated expectations becomes clear (Bruer, Chapter Five, this volume). What is needed is not a quick fix from neuroscience, which will not work for education, but the creation of a new field that integrates neuroscience and other areas 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, Daniel, Immordino-Yang, Stern, Battro, & Koizumi, 2007), can transform schools and education in the long term 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, and 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 and how it changes in positive and negative ways, such as in learning to read or becoming addicted to a drug. These advances in tools for imaging the brain promise to improve education by showing, for example, how learning occurs; how a math class can change the ways that neurons connect to form networks for processing information in the brain; how different languages can shape perception and memory in the brain; and how fundamentally emotions shape thinking, learning, and beliefs.

In the midst of all this new science, the deep need for extending and improving education is clear, for North America and for the rest of 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 is the best single way not only to promote learning to read but also to stimulate economic growth, improve the health of infants and their mothers, and 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 is possible. These high expectations are coming together with the advances in brain science and related disciplines, leading to hope 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 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 build usable knowledge that will inform educational practice, illuminating how learning occurs in schools and other 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 a young field, not a mature science, and educational neuroscience is even younger, with only a small number of researchers 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, 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; see the chapters in Part Five of 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 (different ways of processing information and acting based on brain organization) 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; Parts Four and Seven 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 make these improvements possible, and a few training programs have recently been established, such as the Mind, Brain, and Education program that we began at Harvard University 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, formulate questions that will be useful for improving educational practice, and study how students learn, both effectively and ineffectively. If neuroscience can help inform the educational process, then it is important that teachers and others in educational roles know something about the brain and learning. This book makes small steps toward this goal as it helps educators begin to build 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 by helping educators 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 book is that it offers readings by diverse scientific researchers that have the potential to inform learning and education. To our knowledge, this book 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. Then the book goes beyond those obvious topics 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, Bernstein, & Immordino-Yang, 2007). 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, building skills and concepts for particular content—a pathway for understanding American history, a pathway for doing arithmetic, a pathway for playing guitar. At the same time they do not act or think in rigidly separated compartments but can relate different contents (Fischer & Bidell, 2006). As they develop their learning along specific pathways defined by content, they are also forming connections among those pathways. Indeed, reading is a perfect example. It requires the integration of the separate domains of visual analysis (written words), sound analysis (spoken words), and meaning, and it also connects children’s interests with their literacy skills, because it is such a powerful tool for learning about topics of interest. Many children learn to read because of a personal passionate interest: they are driven to read to find out more about animals or how a lawn mower works or the Civil War (Fischer & Fusaro, in press). To become educated persons and effective citizens, students ultimately need to learn a wide range of skills, built on an educational foundation that their teachers and parents carefully construct to foster learning, motivation, personal responsibility, and creativity.

The brain is 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 and 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.