Introduction

The Emerging Field of Neuroeducation and 21st-Century Schools

Because of its broad implications for individual and social well-being, there is now a consensus in the scientific community that the biology of mind will be to the twenty-first century what the biology of the gene was to the twentieth century.

—Eric Kandel, *In Search of Memory,* p. xiii

As lawmakers look to redefine federal legislation that drives national educational policy, efforts to reform American schools should begin by changing the very notion of how to measure educational success, driven by the movement of 21st-century learning and ultimately informed by new knowledge from the science of learning. At present, with no national consensus on what makes an effective school, federal policies have reduced the notion of measuring successful schooling to merely tracking achievement scores in reading and mathematics.

Clearly, educators must not shrink from accountability for student performance. The current practices that measure educational effectiveness, however, are driving school policies and practices and have resulted in a well-documented narrowing of the curriculum, reducing time spent in the social studies and the sciences and—at the same time—diminishing opportunities for many children to participate in the visual and performing arts, physical education, and even recess. This is especially true in urban settings, where budgets are tight and many educators believe that children require more time to work in the tested subject areas. The present focus on narrow educational goals could well be contributing to the fact that nearly half of the students in public school systems in major cities drop out of school (Swanson, 2008)—at a time when a highly educated population is necessary for our country to continue to take part in a global economy. Moreover, narrow accountability measures fail to give

the public, from parents to policymakers, the broad measures of school effectiveness they want and deserve.

In a recent study at University of California Riverside, teachers indicated that, while the practice of high-stakes accountability helps identify expectations of student learning, it also cuts down on the time they have to provide students with deeper and more engaging learning experiences (Guggino & Brint, 2010). These teachers represent many across the country who feel continual pressure to improve test scores rather than to help students develop the ability to think critically and apply knowledge creatively. Practices that support narrow, "spoon-fed" thinking are incompatible with our nation's need for workers capable of collaboration, innovation, and creative problem-solving—the hallmark of 21st-century skills.

Educating the citizens of tomorrow will require the redesign of school policies and practices so that students do not merely acquire information, but also are provided with opportunities to apply what they have learned in novel ways.These are the very abilities identified by the Partnership for 21st-Century Skills (www.p21.org) as necessary for the workforce of the future.The framework designed by the Partnership includes four major areas of expertise that students should master in order to be prepared for the demands of work and life in their future. They include the following:

- Core subject knowledge in English, reading, language arts, world languages, art, mathematics, science, history, geography, economics, government, civics as well as the understanding of global awareness literacy in finance, business and health;
- Learning and innovation skills such as creativity, critical thinking, problem-solving, collaboration, and communication;
- Technology, media, and information literacy;
- Career and life skills such as self-direction, leadership, the ability to adapt to new situations, and skills in working in a diverse cultural and social environment.

As we redefine American education to embrace the concept of 21st-century schools, the emerging field of neuroeducation can play an important role by focusing educators on *how students learn* rather than on merely *what they learn* based on narrow achievement goals. As neuro- and cognitive science researchers continue to accrue knowledge about the science of learning, it is important that relevant findings reach educators in a manner that allows them to incorporate this knowledge into policies and practices. As is the norm in medicine, neuroeducation can bring

to educators the "bench to bedside" approach through which research informs practice and the needs of practitioners drive research questions.

There is considerable evidence that this approach holds great promise. Neuro- and cognitive scientists have already made important contributions to the work of educators. For example, from her research on executive function and clinical practice with school-aged children, Martha Denckla, M.D., of the Kennedy Krieger Institute encourages educators to examine critical periods in various domains of child development that can inform decisions pertaining to the readiness of preschool-age children for reading instruction or the young adolescent for the conceptual thinking that algebra requires (Hardiman & Denckla, 2010). Paula Tallal, PhD, Co-Director of the Center for Molecular and Behavioral Neuroscience at Rutgers University, has integrated her research on the fundamental role of rapid auditory processing in language development and literacy with basic neuroscience research on neuroplasticity (Tallal, 2004). She has translated this body of research into a series of cognitive skill, language, and reading intervention programs that are used in classrooms around the world to help English language learners, struggling readers, and children with neurocognitive disorders. The work of Ronald Dahl (2004), Jay Giedd (2010), and others encourage educators to examine research on adolescent sleep patterns to inform practices such as school start times. Further, Raizada and Kishiyama (2010) suggest that basic science can demonstrate neural changes underlying the behavioral changes that are observed from specific educational interventions. They suggest that finely tuned neural measures can provide evidence as to whether particular educational interventions are causing anatomical or functional brain changes; this in turn might be predictive of behavioral changes that endure beyond the period immediately following the intervention.

It is clear that a growing number of educators also see the potential of the science of learning to inform the field of education. During the last 10 years, teacher attendance at national, regional, and local conferences related to learning and the brain has grown and teachers report that information from the neuro- and cognitive sciences is highly relevant to their work (Howard-Jones, Pickering, & Diack, 2007). As professional development programs, books, and journal articles have proliferated, however, there has emerged a strong need for some way to separate the wheat from the chaff when it comes to commercial products and textbooks that increasingly tout the use of "brain-based" strategies to improve student achievement (Sylvan & Christodoulou, 2010). Teachers must have ongoing information that helps them become informed consumers of research claims, and a cohesive way to apply relevant research to effective practice.

The BTT Model is presented as a tool for applying neuro- and cognitive science to educational practice that is consistent with the skills associated with 21st-century learning—preparing all students to become the creative and innovative thinkers and learners of tomorrow.