Editorial

This issue of LEARNing Landscapes shares historically, theoretically, and practically how the fields of neuroscience, psychology, and education are working together to get a more cohesive understanding of the physiology of the brain, and to implement learning in more effective ways.

In the 1970s classroom teachers were influenced by the renewed interest in the work of pragmatist and educator, John Dewey (1916), who advocated strongly for learning by doing and for including the arts/aesthetics in education, and by the work of psychologist, Jean Piaget (1962), who demonstrated the significance of the early learning that occurs when a child interacts with his or her environment.

By the 1980s, the work of Lev Vygotsky (1978) had been translated from Russian into other languages, and educators realized that language mediates learning and, therefore, the social interaction among peers, with caregivers, and teachers, contributes significantly to how learners construct and understand their worlds. The work of psychologist Howard Gardner (1983) on multiple intelligences sent a message to the world about the need to tap into the various strengths of students and to permit them to use multiple modes for "receiving" and communicating/representing their learning. At the same time, sociolinguist and educator Shirley Brice Heath (1983) was showing not only how important it is to start the learning from where the child is and where his/her propensities lie, but also to be aware of and value where the child is coming from to enhance his or her potential.

A missing piece in the evolving understanding of learning was what was developing in the field of neuroscience, particularly in the 1990s. New and sophisticated imaging technology permitted scientists to actually see the brain at work and provided new insights about learning. It is the recent integration of mind, brain, and education (MBE) research that is helping to enhance our understanding of learning and contribute to more effective teaching. This issue illustrates many aspects of MBE work and how practice is being affected by it.

Invited commentaries

We are privileged to have commentaries from eminent scholars working at the intersection of the mind, brain, and education fields. Renate Caine, who is the executive director of the Natural Learning Research Institute, and Geoffrey Caine, who is co-director of the Caine Learning Center, both in Idyllwild, California, argue strongly for reconfiguring the "memes" of learning (ideas, behaviors, or styles that people adhere to within a culture) that have been perpetuated, and to match how the brain makes sense of experiencing by using inquiry in the classroom.

Sawyer, a professor of psychology and education at Washington University in St. Louis, kindly agreed to an interview in which he underscores the importance of creativity and collaboration in learning in order to prepare students for working lives that demand creativity, flexibility, and adaptability. He discusses with an interesting example how innovation is usually the result of collaboration rather than a particular insight of a single individual.

Sousa, who is an international consultant in educational neuroscience, an adjunct professor at Seton Hall University, and visiting professor at Rutgers University, discusses findings that have been discovered about the brain and the implications these have for learning. For example, the brain cannot multitask—it just alternates from one task to another. This increases mental effort and results in the loss of working memory for the initial task. Furthermore, emotions are what alert the brain's attention systems, and therefore, experiences that include emotions are more likely to be remembered. These three commentaries provide an excellent overview of the discussions and insights that are emerging from the integrated research on MBE and provide a framework for what follows.

The articles by the contributors to this issue are presented in the journal in alphabetical order. In this editorial, I discuss their work thematically.

History of neuroscience education

In a very helpful article, Ferrari and McBride, both teachers of psychology at the University of Toronto/OISE, trace the history of the development of the MBE field back to the work of Hippocrates (4th-5th century B.C.) and the philosophers that followed, to the time of the birth of and focus on developmental psychology in the work of James, Hall, Piaget, Vygotsky and others in the late 19th to mid-20th centuries. They attribute the emergence of the field of MBE to the likes of Hebb, Chall, and Mirsky, Gardner, Hart, Posner, and Gazzaniga. These scholars helped to move what had been

educational neuropsychology into the field of MBE, which significantly emphasizes the importance of examining learning and teaching, rather than just learning and the brain. Ferrari and McBride go on to dispel some long-held "neuromyths" about the brain and make a plea for teachers and neuroscientists to work together, and to ensure that research results are made accessible to all stakeholders.

Importance of emotions in learning

Immordino-Yang, an assistant professor at the Rossier School of Education and in the Brain and Creativity Institute at the University of Southern California (USC), uses the reprint of her article with Antonio Damasio, a professor of neuroscience and the director of the Brain and Creativity Institute at USC, to lay the groundwork for her study with her young daughter, Nora Ming-Min Yang, where she analyzes longitudinally the social emotions and scientific concepts revealed in her daughter's poetry. In the original article entitled, "We Feel, Therefore We Learn: The Relevance of Affective and Social Neuroscience to Education," Immordino-Yang and Damasio discuss how emotional processes act as a "rudder" in the transfer of both knowledge and skills, that emotion plays an important and necessary role in decision making, and that it is the interface between emotion and cognition that leads to creativity. In her subsequent article, Immordino-Yang describes, with lovely examples, how her daughter Nora's developing understanding of the physical and social world is intertwined and is illustrated in her poems written from age six to age nine. In fact, Immordino-Yang suggests that she is probably compelled to write because

> By virtue of its evolutionary connection to bodily feeling and survival, our social mind motivates us to create things that represent the meaning we have made by processes of noticing, feeling, and understanding so that others can notice and feel and understand what we have. (pp. 134–135)

Ritchie, who is a consulting scientist and an adjunct faculty member at Dalhousie University in Halifax, Nova Scotia, Shore, who is an emeritus professor of psychology at McGill University, LaBanca, who is the director of the Center for 21st Century Skills at Education Connection in Connecticut in the United States, and Newman, who is an associate professor of neurology, also at Dalhousie, argue, too, that emotions have a big impact on thinking and creativity. Quick or concise thinking, often called convergent thinking, which is frequently encouraged in classrooms, has its etiology as a functional response by the brain to threatening situations. Divergent thinking, or the ability to see relationships in unconventional ways, is what is needed to innovate and problem solve in the

complex and global society of today. They discuss how inquiry learning helps to encourage the latter type of thinking because it is self-directed and personal, it heightens positive emotions such as interest or excitement, and as a result "emotional valence" is increased and creativity is enhanced. They have embarked on a study using electroencephalography to collect data about how the brain can be seen to respond physiologically when participants are exposed to heightened, positive emotions and hope to relate their findings to experiences in inquiry settings.

Holistic and integrative functions of the brain

Leggo, a poet and professor of education at the University of British Columbia, describes how in the word play that takes place in creating poetry one must attend to words, sounds, shapes, and rhythms in holistic and integrative ways for the brain to produce, to be compelled to ask questions, and live with ambiguity and the "mysteries" of the world. He suggests through lovely examples how his word play portrayed in five poems illustrates the interconnections among body, brain, language, heart, and spirit, and believes this process lays the groundwork for a "pedagogy of the imagination" needed for educational well-being.

Emmerson, a PhD student at the University of Saskatchewan, describes how her experience playing music in her youth with a group known as "Martha and the Muffins" gave her pause to wonder about why music is so potent. Using the work of Levitin, among others, she describes how music has an evolutionary basis with an emotional potency because it was originally used sexually to attract a partner. Furthermore, music uses particular brain structures, including dedicated memory systems that remain functional when other systems fail. She argues that the emotional capacity of music and the memory systems it develops have much potential for integrating the intellectual, social, and emotional dimensions of education.

Focus on the adolescent brain

Willis, neurologist, international professional development educator, and former middle school teacher in Santa Barbara, California, has lived in the nexus of neuroscience, psychology, and education. I had the pleasure of hearing her present to adolescents in a local school in Montreal where she explained the fundamentals of how the brain functions and the implications of this for their studies. She zeroes in on the prefrontal cortex and how the executive functioning of this area of the brain and the branching axons and dendrites can promote conceptual thinking which includes critical analysis, judgment, prioritizing, organizing, problem solving, and long-term

goal development. She advocates for stimulating the neuroplasticity of the adolescent brain in transfer tasks such as robotics to increase long-term conceptual storage. According to Hebb (1949), neurons that fire together, wire together. This has implications for classroom learning. In addition, other work shows that this idea is helpful for dealing with post-traumatic stress and addiction because "de-wiring" too is possible (Brunet et al., 2011).

Anderson, the chair of the Department of Mathematics and Science and Technology at Teachers College, and a senior research scientist at Columbia University, explores how humans encode information in memory and how it is recalled and organized in response to contextual clues. He suggests that a "contextual-label-pointer" (CLP) model shows how the frontal lobe activity of the brain organizes the construction of information in working memory guided by the rules of a particular context. He advocates that teachers use multimodal presentations and encourage multimodal representations to help students build networks of concepts and ideas that facilitate learning.

Feinstein, who is a professor and chair of the Education Department at Augustana College in Sioux Falls, South Dakota, notes that the teenage brain has a particular propensity for academic and emotional growth. Furthermore, she suggests that the current technology can be very suitable for enhancing this growth based on how the brain works. However, she cautions about the types of technology that only encourage multitasking and quick decision making. Because the chemical dopamine plays a significant role in how the brain engages in learning, but diminishes once something is learned, she encourages teachers to increase the complexity of the work as it progresses to keep students motivated.

Focus on tertiary education

MacEachren, who is the coordinator of the Outdoor and Experiential Education Program in the Faculty of Education at Queen's University in Kingston, Ontario, shares an interesting approach that she developed to help her and her university students to understand learning. Using the common practice of knitting which Waldorf educators advocate while simultaneously learning something else, MacEachren decided to have her teacher candidates learn to knit a pair of socks during a course with her (it should be noted that this would not be considered multitasking because it puts demands on different parts of the brain). She had them journal this experience in order to help them document and understand how the brain learns. She discusses how her own growing knowledge about the brain was enhanced during this process.

Now she understands more fully through practical experience how the brain is hard-wired to learn, and how its mirror neurons respond to modeling (in this case knitting), which she did with her students. Students' reflections show how they grasped these understandings and will use them in future classroom work.

Maynes and Julien-Schultz, both assistant professors at the Schulich School of Education at Nipissing University in North Bay, Ontario, show with examples how they used graphic organizers to help teacher candidates conduct their lesson planning, and how these students used reflective writing (metacognition) to explore the internalization of, and connections among, pedagogical concepts.

Kerwin-Boudreau, a psychology teacher at Champlain College in St. Lambert, at the University of Sherbrooke, and at McGill University, all in Quebec, describes how she uses a four-phase, instructional model to engage her students in designing a robot's brain. Not only do the students learn a great deal about the various parts of the brain and how the brain functions, but this inquiry assignment is also a good example of the emotional engagement it generates and, as discussed above, is required for learning.

Focus on school-based learning

Greenstone, a psychologist who is the director of the Centre MDC, an interdisciplinary care facility in Montreal, gives an overview of the basic domains of the executive functioning skills in the brain, and as others in this issue have said, she posits that these skills are extremely important for goal-directed behavior, social behaviours, and emotional well-being. She attributes a lack of these skills is often at the root of the problems that students have in school. She describes with two examples how from what is known about brain plasticity, that it is never too late to focus on and use organizers to help develop these functions in students.

Lipsett, an early childhood teacher at a Title One school in Fairfax, Virginia, discusses, using an example of a kindergarten child, how she used her knowledge of brain research to help her students be "available" for learning. She contends that young students have to first acquire the means to regulate the emotions that get in the way and prevent learning. She helps her students to observe, recognize, and label emotional responses in others and in themselves, and ultimately to draw on appropriate responses from within. She outlines the interventions she used and the success she achieved while working with seven children in a small-group, social skills session over a period of several weeks.

Rupley, who is a professor of education, Robert Capraro, who is a professor of mathematics education, and Mary Margaret Capraro, who is an associate professor of mathematics education, all at Texas A&M University, are interested in the nexus between reading and mathematical problem solving. In a review of the literature they have found little either in textbook materials or mathematic programs that ultimately enhances student achievement, but rather the best possible predictor is in how mathematics is taught. They suggest that both reading and mathematical problem solving use similar cognitive components—recognizing the patterns of text organization, generating patterns, attaining a goal (that is, recognizing if a goal has been attained or not), which they call RGA Theory. They show with examples how this theory works in practice, making a case for the interdependence and interconnectedness of reading and mathematics and suggest that children must be taught early on to "intertwine reading and mathematical cognitive strategies to make meaning of word problem-solving events" (p. 244).

Last, but certainly not least, Webster, a high school teacher at an independent school in Montreal and a PhD student at McGill University, and Bossé, who is the assistant head of curriculum and director of the centre for learning and enrichment at the same school, show, using an interesting example of one student, how they modified dramatically their perceptions about special needs students. They reflected on their observations of and documentation about this young man during his time in school. Subsequently, after he completed high school, they conducted an interview with him, his mother, and some of the other professionals involved in his formal education. The results of this process give credence to the need to identify and focus with the student on areas that need attention, to differentiate and scaffold student learning using multimodal approaches, and to attend to how the various contexts of the school are engaging each student. These results corroborate much of what has been said in varying ways about MBE throughout this issue. Most importantly, they illustrate just how critical and useful it is to include students in the inquiry process.

LBK

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