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Use Your Head: Neuroscience Research and Teaching

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Introduction

"It’s a no-brainer!" We often hear that phrase used to describe something the speaker sees as obvious? In the world of learning, however, there is no such thing as a "no-brainer." While we may not often think about it explicitly, we know the brain is at the heart of all our learning. Still, little of our teaching is designed with the brain in mind, despite the growing popularity of books and conferences on "brain-friendly" or "brain-based" learning.

> Brain-friendly learning is not about techniques and gimmicks. It is far more than just playing baroque music or playing fun games. It’s a movement rather than a method. A movement to recover the real joy of learning—combining substance with sizzle—and helping people become even more outstanding at the work they have chosen to do. (Hare, 2012)

Since everyone wants to be "even more outstanding," this pitch seems almost irresistible. The quotation promotes the services of a consultancy, Kaizen Training (http://www.kaizen-training.com/ [http://www.kaizen-training.com]) and is clearly meant to be both inspirational and informative.The task for educators at all levels is to be able to determine whether claims about "brain-based learning" are actually supported by research.

Brain science is a new and complex field has emerged with the application of new technologies for brain imaging like Magnetic Resonance Images (MRIs) and Computer Axial Tomography (CAT) scans.Since the brain is the site for learning, educators educators stand to benefit from this knowledge when it is applied to improving methods of teaching or improving conditions for learning. In this article, I look at some of the ways that learning about the brain translates to an enhanced understanding of what faculty can do. However, it is important to note that understanding brain science demands more time and effort than reading a single book or attending a workshop (Twadorsz, 2007). This article will not introduce even a tiny fraction of what has been learned about the brain in recent years, but I hope that it will

- make clear that there is a need for educators to learn more about the brain,
- provide some resources to support them in further independent learning about the topic, and
- make the case that the work involved in learning about the brain is time well spent.

Fundamentals about the brain

The brain is composed of nerve cells called neurons. Each neuron has a receiving end, called a dendrite and a sending end that branches out into synapses. Small electrical signals travel along the neurons and fire like microscopic spark plugs from the synapses into the cerebrospinal fluid. Those small charges energize molecules of brain chemicals (e.g., serotonin or norepinephrine) that may then float into a "docking station" on the dendrite side of another nerve cell. This complex network of electrochemical connections is the foundation of brain work-receiving and sending information, linking bits of information to one another, interacting with muscles and organs, etc. With billions of neurons, the number of possible connections is literally astronomical.

Although few college educators are likely to have the mastery of biology and chemistry to follow developments in brain science in neuroscience journals, instructors may still learn enough to improve their approach to teaching and learning. We can expect that educational psychologists and curriculum specialists will be hard at work digesting some of the neuroscience research and finding ways to put it to work. Therefore,a basic understanding of brain structure and function should help instructors understand how the brain processes information. In the following material, I have provided some links to information sources that will help college faculty to understand this knowledge and to learn how they can structure classes for maximum benefit for their students.

Resources for personal professional development

While Twadorsz (2007) recommends taking undergraduate courses to achieve this end, busy college educators may find that there is much to be learned from independent study of the basics about brain anatomy and function. For example, they might find it valuable to start with a University of Alberta tutorial that communicates the basics clearly (http://www.psych.ualberta.ca/~ITL/brain/module1.htm).

Another resource is the online book, *How People Learn: Brain, Mind, Experience, and School* (Bransford, Brown & Cocking, 2000). Although the book was published over a decade ago, the information was compiled by a panel of experts on learning and it is still applicable today. The authors emphasize that learning research supports the following principles:

- learning changes the physical structure of the brain,
- learning organizes and reorganizes the brain, and
- different parts of the brain may be ready to learn at different times. (p.115)

The book deserves to be on every educator’s virtual bookshelf.
Caine and Caine (1990, 1991) also did early work on applying brain research, including a list of 12 principles of brain-based learning derived from the research available at that time, but Caine and Caine have recently shown that the principles have held up well over the past 20 years (Caine & Caine, n.d.). The principles include such ideas as "learning always involves conscious and unconscious processes" and "complex learning is enhanced by challenge and inhibited by threat associated with helplessness."

Research on learning tools

With a basic understanding of brain function and anatomy, educators would also benefit from developing an understanding of the research tools of neuroscience. Before the 1980s, our understanding of the brain was informed by animal research, autopsies on humans, and observations made during brain surgery—that is, we had few ways of studying what brains normally do in healthy humans. Since that time, however, the various imaging technologies have allowed us to observe how there is more blood circulating in the active areas of the brain. That has made it possible to examine the relationship between brain activity and events in the learner’s world. We have also learned to combine x-ray or radiation-based images with computer technologies to create three dimensional images of brains "at work," including the possibility of seeing tumors or damaged areas without surgery. Increasingly, these imaging tools are providing insights about how the brain changes when we learn.

Neuroplasticity

Among the recent discoveries of neuroscientists is that the brain is actually capable of changing itself. Thirty years ago, this idea would have been rejected out of hand by most neuroscientists, but the evidence is now strong and clear. Clinical psychologist Norman Doidge provides startling examples of this research in his best-seller, *The Brain that Changes Itself.* Doidge tells the story of a woman who had lost 98% of the brain tissue associated with the sense of balance. She regained it by wearing a gyroscopic helmet attached to electrodes connected to her tongue. Most interestingly, with enough experience using this device, her brain discovered a way to restore her sense of balance *without* her wearing the helmet. Another pioneering study provided a blind patient with some limited vision by sending signals from a video camera to electrodes attached to his back. Yet another study used video games in a program called FastForword to develop language skills in people with brain damage and, later, to autistic children. Doidge cites the Arrowsmith School in Toronto, Ontario, as one of the pioneers in the application of brain science to schooling for children with learning difficulties.

The dramatic visual images involved not only in the brain scans that demonstrate this plasticity but also in the behaviours that reflect it provide an excellent way for college instructors to learn more about brain plasticity by viewing videos like those listed in the appendix.

Classroom Applications

Although attempts to develop classroom applications based on brain science are in a very early stage of development, instructors may consider the following possibilities as ways toward more brain-sensitive teaching:

- *Provide many different examples of concepts you are teaching and make explicit connections to other things.*

  It is easier to remember things that have many different connections. Include rhymes when working with numbers and show pictures of things you talk about. Ask learners what comes to mind when you use specific vocabulary that they need to learn. All of this is standard practice for most elementary teachers, but the disciplinary focus of high school and the vocational emphasis in college programs makes this more challenging for instructors of older learners. A little creativity is needed to find ways to incorporate such things without seeming to treat the learners like children. On the other hand, it can be rewarding and surprising to see that older students enjoy such methods.
- *Encourage learners to make use of songs (or to invent songs) to help with any memorizing they must do.*

  It seems paradoxical, but even though you are adding more information when you put words to music, the melody somehow enhances memory. This is likely a consequence of centuries of oral history in the form of song—those who could learn the songs also learned the lessons of the ancestors and had a better chance of survival, so they became our ancestors. This principle was creatively depicted in an episode of the old TV sitcom *Cheers* when Coach taught Sam how to prepare for a geography test: "Albania, Albania, you border on the Adriatic…"
- *Notice when learners seem tired.*

  During sleep, the brain rehearses the day’s learning and makes connections between new ideas and old ones. If students are chronically tired, it might be a good idea to explain this to them and to encourage them to try to get more sleep.

- *Focus on activities that give learners a genuine feeling of accomplishment.*

  One model of depression is "learned helplessness"—learning that the world does not respond to your behaviour. In animal studies (e.g., Peterson, Maier & Seligman, Seligman, 1993) brain chemistry was shown to change when animals learned that their behaviour failed to result in changes in the environment. On the other hand, experiences of success affect the brain positively—Seligman calls this "learned optimism." It is important that these successes be real and consequential, not just unwarranted praise for the learner.
- *Demonstrate what it means to pay attention and help learners to attend better.*

  Learning requires attention but students increasingly live in a world where scattered attention is the norm (think multi-tasking, think iPod, think "texting"). Neuroscientists generally emphasize the importance of doing one thing at a time to enhance learning. Help students understand the importance of being focused and be sure that you have a rich repertoire of attention-getting techniques in your arsenal (raising and lowering voice, speeding up and slowing down, use of images and sounds, telling jokes and stories, having them listen and having them talk, moving around the room, having them move, etc.). In general, try to change SOMETHING every 10-15 minutes as a way of recapturing attention—and let them know why you do this.

A cautionary conclusion

With appropriate academic scepticism and scientific caution, Willingham (2007) has taken pains to point out that much of what is now coming to light about the ways that brains work is not really in a form that would support the leap to applications in the classroom. It will be a long time before neuroscience gives us firm direction on how to teach music or how best to organize a science lab. In the meantime, the principles discussed here and the resources cited may serve both to help faculty to improve their teaching.The day will come when we have much more specific knowledge of how the brain functions and how we can put that knowledge to work to support learning. In the meantime, teachers should be ensuring that they are ready to adapt. If they do, historians will probably call this "the education century."

References

Arrowsmith School. http://www.arrowsmithschool.org

Bransford, J., Brown, A., & Cocking, R. (2000). *How People Learn: Brain, Mind, Experience, and School.*Washington: National Academy Press. Available: http://www.nap.edu/catalog.php?record_id=9853

Caine, R. N., & Caine, G. (1990).Understanding a Brain-Based Approach to Learning and Teaching.*Educational Leadership,* 66-70. Available:http://www.coe.iup.edu/grbieger/classes/curr910/Readings/Brainbasedlearning.pdf

Caine, R.N., & Caine, G. (1991).*Teaching and the Human Brain*. Alexandria, VA: Association for Supervision and Curriculum Development. Available: http://eric.ed.gov/PDFS/ED335141.pdf

Caine, R.N., & Caine, G. (n.d.).*Overview of the Systems Principles of Natural Learning*. http://www.cainelearning.com/files/Summary.pdf

Doidge, N. (2007).*The Brain that Changes Itself*. New York: Penguin Books.

Human Brain Anatomy Study Module (1999).Psychology Department, the University of Alberta. Available: http://www.psych.ualberta.ca/~ITL/brain/module1.htmRetrieved: 28 Oct., 2010.

Peterson, C., Maier, S., &Seligman, M. (1993*).Learned Helplessness: A Theory for the Age of Personal Control*. Oxford: Oxford University Press.

Twadorsz, S. (2007).Exploring Neuroscience: A Guide for Getting Started.*Early Education and Development*, 18(2), 171–182.

Willingham, D. T. (2007).*Brain based learning: More fact than fiction*. Available: http://www.societyforqualityeducation.org/newsletter/Feb07/brainbased.pdf

Appendix
Additional Resources

The key message in this article is that instructors need to become more familiar with the role of the brain in learning. The readings, online resources and videos listed here may help them pursue that objective.

Related Readings

Aamodt, S & Wang, S. (2008). *Welcome to your Brain: Why you Lose your Car keys but Never Forget how to drive and Other Puzzles of Everyday Life*. New York: Bloomsbury.

Ackerman, D. (2004). *An Alchemy of Mind: The marvel and Mystery of the Brain*. New York: Scribner.

Gerhardt, S. (2004).*Why Love Matters: How Affection Shapes a Baby's Brain*. New York: Brunner/Routledge.

Hare, Kimberly. (2012). *Learning Professionals' Gym* (web blog). Available: http://lpgym.wordpress.com/ Retrieved 23/01/2012.

Howard, P. J. T*he Owner's Manual for the Brain: Everyday Applications from Mind Brain Research*. Austin: Bard Press.

Jensen, E. (2006). *Enriching the Brain:How to maximize every learner's potential*.SanFrancisco:Wiley.

Lynch, Z. (2009). *The Neuro Revolution: How Brain Science is Changing our World*. New York: St. Martin's Press.

Nunn, K., Hanstock, T., &Lask, B. (2008).*Who's Who in the Brain: A Guide to its Inhabitants, Where they Live and What they do*. London: Jessica Kingsley.

Restak, R. (2003). *The New Brain: How the Modern Age is Rewiring your Mind*. New York: RodaleBooks.

Stien, P. T., & Kendall, J. (2004).*Psychological Trauma and the Developing Brain: Neurologically Based Interventions for Troubled Children*. New York: Haworth Press.

Wolfe, P.,&Nevills, P. (2004). *Building the Reading Brain, PreK–3*. Thousand Oaks, CA: Corwin Press.

Online resources (All links worked at time of publication.)

FastForword
http://www.fastforword.com.au/Content_Common/pg-Research-behind-Fast-ForWord.seo

Positive Psychology Centre, University of Pennsylvania. http://www.ppc.sas.upenn.edu/index.html

Resources for Science Learning: The Human Brain. The Franklin Institute
http://www.fi.edu/learn/brain/proteins.html

Dr. MichaelMerzenich's blog (developer of FastForword)
http://merzenich.positscience.com/

Dr. Bill Hunter's del.i.ci.ous learning bookmarks
http://www.delicious.com/ilprofessori

Online videos:

The Mind, Teacher Resources, The Annenberg Center
http://www.learner.org/resources/series150.html?pop=yes&pid=1632#

Norman Doidge: The Neuroplasticity Revolution (an update)
http://fora.tv/2010/09/02/Norman_Doidge_The_Neuroplasticity_Revolution_An_Update#fullprogram

Michael Merzenich: Rewiring the Brain
http://fora.tv/2010/11/18/Michael_Merzenich_Rewiring_the_Brain#fullprogram

Oliver Sacks on Manipulating the Brain
http://video.answers.com/oliver-sacks-on-manipulating-the-brain-297703386

V.S. Ramachandran on Your Mind
http://www.ted.com/talks/vilayanur_ramachandran_on_your_mind.html

Dr. Dan Willingham's caution: Brain-based learning: not ready for prime time
http://instructionaldesignfusions.wordpress.com/2010/07/03/brain-based-learning-not-ready-for-prime-time/

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