What Mind, Brain, and Education (MBE) Can Do for Teaching

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The following is an excerpt from Mind, Brain, and Education Science: A comprehensive guide to the new brain-based teaching (W.W. Norton) a book based on over 4,500 studies and with contributions from the world’s leaders in MBE Science.

“What a thing is and what it means are not separate, the former being physical and the latter mental as we are accustomed to believe.”

—James J. Gibson, “More on Affordances” (1982, p. 408)

Evidence-Based Solutions for the Classroom

How do we learn best? What is individual human potential? How do we ensure that children live up to their promise as learners? These questions and others have been posed by philosophers as well neuroscientists, psychologists, and educators for as long as humans have pondered their own existence. Because MBE science moves educators closer to the answers than at any other time in history, it benefits teachers in their efficacy and learners in their ultimate success.
Great teachers have always “sensed” why their methods worked; thanks to brain imaging technology, it is now possible to substantiate many of these hunches with empirical scientific research. For example, good teachers may suspect that if they give their students just a little more time to respond to questions than normal when called upon, they might get better-quality answers. Since 1972 there has been empirical evidence that if teachers give students several seconds to reply to questions posed in class, rather than the normal single second, the probability of a quality reply increases.[1] Information about student response time is shared in some teacher training schools, but not all. Standards in MBE science ensure that information about the brain’s attention span and need for reflection time would be included in teacher training, for example.

The basic premise behind the use of standards in MBE science is that fundamental skills, such as reading and math, are extremely complex and require a variety of neural pathways and mental systems to work correctly. MBE science helps teachers understand why there are so many ways that things can go wrong, and it identifies the many ways to maximize the potential of all learners. This type of knowledge keeps educators from flippancy generalizing, “He has a problem with math,” and rather encourages them to decipher the true roots (e.g., number recognition, quantitative processing, formula structures, or some sub-skill in math). MBE science standards make teaching methods and diagnoses more precise. Through MBE, teachers have better diagnostic tools to help them more accurately understand their students’ strengths and weakness. These standards also prevent teachers from latching onto unsubstantiated claims and “neuromyths” and give them better tools for judging the quality of the information. Each individual has a different set of characteristics and is unique, though human patterns for the development of different skills sets, such as walking and talking, doing math or learning to read, do exist. One of the most satisfying elements of MBE science is having the tools to maximize the potential of each individual as he or she learns new skills.

Figure 2.1 Discipline and sub-disciplines in Mind, Brain, and Education Science
Education is now seen as the natural outgrowth of the human thirst to know oneself better combined with new technology that allows the confirmation of many hypotheses about good teaching practices. Past models of learning, many of which came from psychology and neuroscience, lay the path for current research problems being addressed today to devise better teaching tools. For example, early in the development of psychology, Freud theorized that part of successful behavior management techniques, including teaching, was the result of actual physical changes in the brain, not just intangible changes in the mind.[2] This theory has since been proven through evidence of neural plasticity and the fact that the brain changes daily, albeit on a
microscopic level, and even before there are visible changes in behavior. These changes vary depending on the stimulus, past experiences of the learners, and the intensity of the intervention. What were once hypotheses in psychology are now being proven, thanks to this new interdisciplinary view and the invention of technology. On the other hand, other past beliefs about the brain have been debunked. For example, it was once fashionable to think of a right and a left brain that competed for students' attention and use. It has now been proven beyond a doubt that the brain works as a complex design of integrated systems, not through specialized and competing right- and left-brained functions. These examples show how past beliefs are now partnered with evidence about the functioning human brain to produce this powerful, new teaching–learning model.

The Five Well-Established Concepts of MBE Science

The following summary of the well-established concepts in MBE science comes from MBE Science: The New Brain-Based Education,[3] which I wrote:

. Human brains are as unique as faces.[4] Although the basic structure is the same, no two are identical. While there are general patterns of organization in how different people learn and which brain areas are involved, each brain is unique and uniquely organized. The uniqueness of the human brain is perhaps the most fundamental belief in MBE science. Even identical twins leave the womb with physically distinct brains due to the slightly different experiences they had; one with his ear pressed closer to the uterus wall and bombarded with sounds and light, and the other smuggled down deep in the dark. There are clear patterns of brain development shared by all people, but the uniqueness of each brain explains why students learn in slightly different ways. Many popular books try to exploit this finding by using it as an “excuse” for the inability of teachers to reach all learners. This is simply irresponsible. The uniqueness of each brain is not to be overshadowed by the fact that humans as a species share clear developmental stages that set parameters for learning.

. All brains are not equal because context and ability influence learning.[5] Context includes the learning environment, motivation for the topic of new learning, and prior knowledge. Different people are born with different abilities, which they can improve upon or lose, depending on the stimuli or
lack thereof. How learners receive stimuli is impacted by what they bring to the learning context, including past experience and prior knowledge. This means that children do not enter the classroom on an even playing field. Some are simply more prepared for the world from birth. This is a harsh reality to face because it explicitly establishes a definitive framework for potential. The key, however, is to maximize this potential. There are thousands of people who are born with the potential or circumstances to be quite smart who do not live up to this possibility, while there are thousands who are born with modest potential, but who maximize this “limitation” well beyond expectations. Genes, previous experiences, and what the child does with his or her potential contribute to the child’s success as a learner.

*The brain is changed by experience.*[6] The brain is a complex, dynamic, and integrated system that is constantly changed by experience, though most of this change is evident only at a microscopic level. You will go to bed tonight with a different brain from the one you had when you awoke. Each smell, sight, taste, and touch you experience and each feeling or thought you have alters the physical form of your brain. Although these brain changes are often imperceptible unless viewed under a powerful microscope, they constantly change the physical makeup of the brain. With rehearsal, these changes become permanent—which can work in both positive and negative ways. Areas of the brain that are used together tend to be strengthened, whereas areas that are not stimulated atrophy. This truth gives rise to the Hebbian synapse concept (1949): Neurons that fire together, wire together. The “wire together” part is a physical manifestation of how life experiences change the brain. In short, it is nearly impossible for the brain not to learn as experience—broadly defined as “knowledge or practical wisdom gained from what one has observed, encountered, or undergone”[7]—changes the brain on a daily basis.

*The brain is highly plastic.*[8] Human brains have a high degree of plasticity and develop throughout the lifespan, though there are major limits on this plasticity, and these limits increase with age. People can, and do, learn throughout their lives. One of the most influential findings of the 20th century was the discovery of the brain’s plasticity. This discovery challenges the earlier belief in localization (i.e., that each brain area had a highly specific function that only that area could fulfill), which lasted for hundreds of years. It has now been documented that neuroplasticity can explain why some people are able to recuperate skills thought to be lost due to injury. People born with only one hemisphere of the brain, who nevertheless
manage to live their lives normally, are an extreme example of this plasticity. Antonio Battro and Mary Helen Immordino-Yang, offer documentation of people with half a brain. Antonio Battro’s work on *Half a brain is enough: The story of Nico* (2000) is a remarkable documentation of one child’s life with just a half a brain and defies previous concepts about skill set location in the brain. Taking Battro’s lead, Immordino-Yang offers the detailed story of two cases in her recent work, “A tale of two cases: Lessons for education from the study of two boys living with half their brains” (2007). She shows how the entire brain works as a single large system, and when parts are missing, as in the case of these two children who were born with only half a brain each, then other parts of the brain can “take over” and learn functions with which they are not normally associated.

Researchers such as Paul Bach-y-Rita make it clear that “we see with our brains, not with our eyes” (as cited in Doidge, 2007, p. 14). That is, the brain as a whole is responsible for sensory perception, not necessarily a single part of the brain. Bach-y-Rita explains this point using a simple metaphor: Let’s assume that you are driving from point A to point B. You normally take the most efficient route, but if a bridge is down or the road is blocked, you take a secondary road. This secondary road might not be as fast as the “natural” route, but it gets you to point B all the same, and it may even become the preferred route if it is sufficiently reinforced.

Perhaps the author who has done the most to explain neuroplasticity to the public is physician Norman Doidge, who has documented studies that “showed that children are not always stuck with the mental abilities they are born with; that the damaged brain can often reorganize itself so that when one part fails, another can often substitute; that is brain cells die, they can at times be replaced; that many ‘circuits’ and even basic reflexes that we think are hardwired are not.”[9]. Neuroplasticity has implications for brains that have been damaged, but also for basic learning in classroom experiences and how we think about education. Whereas it was popular in the 1990s to think of the “crucial” early years, it is now acknowledged that learning takes place throughout the lifespan. Does this point speak against the privileging of early childhood educational practices? Not at all; it simply means that under the right conditions, the skills that identify normal developmental stages should be seen as benchmarks, not roadblocks, because humans can learn throughout the lifespan.
The brain connects new information to old.\cite{10} Connecting new information to prior knowledge facilitates learning. We learn better and faster when we relate new information to things that we already know. This principle may sound like it needs no evidence—we experience it every day. For example, let’s say you are going somewhere you have never been before. When someone gives you directions, it is very helpful if they offer you a point of reference that is familiar to you (“You’ll see the post office; from there, turn right at the next corner”). Similarly, when a child learns, he or she builds off of a past knowledge; there is no new learning without reference to the past.

It is unfortunate that new concepts are sometimes taught in schools in a conceptual vacuum without anchoring the information to what students already know. This vacuum is the reason that students who have a poor foundation in a particular subject will continue to fail. How can a child who does not understand addition move on to understand subtraction? To use a house-building metaphor, if we have a weak foundation, then it is irrelevant how sturdy the walls are, or how well built the roof is; the structure cannot be supported. This is an argument for quality instruction in the early years. Without a firm foundation in basic mathematical conceptualization (or basic concepts in language, values, artistic or social content, for that matter), then a student will have a lot of trouble moving on to build more complex conceptual understandings.

The well-established concepts in MBE science are not new ideas. All five have been around for decades, if not centuries. What is new is that all five concepts have been proven without a doubt in neuroscience, psychology, and educational settings, adding to their credibility for use in planning, curriculum design, classroom methodology design, and basic pedagogy. What is new is their consistent application in best-practice classroom settings. These five “truths” should guide all teaching practices as well as future research on better teaching tools.\cite{11}

References


Books on this topic by Tracey Tokuhama-Espinosa:


[1] Studies that offer evidence to this effect include Chun & Turk-Browne (2007); Pashler, Johnsyon, & Ruthruff (2001); Posner (2004); Sarter, Gehring, & Kozak (2006); Smallwood, Fishman, & Schooler, (2007); Stahl (1990); Chiles (2006); Thomas (1972).


[11] For a thorough review of each OECD category, readers are invited to read Mind, Brain, and Education Science: The New Brain-Based Learning (Tokuhama-Espinosa, 2010a).