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Myths or Misnomers: Research-based Realities in the Classroom Literature Review for Deans for Impact (2015)

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This article proposes the importance of forming an interdisciplinary partnership between neuroscientists, cognitive scientists, college professors, and professional educators, to dispel long perpetuated myths and to increase the research-based underpinnings of education. Professional educators have a unique opportunity to combine their expertise in the classroom with neuroscientists and cognitive scientists to dispel myths and develop theories and practices based on sound scientific research; thus, supporting education and learning in the classroom.

Keywords: cognitive development, learning styles, brain lateralization, brain science

DEANS FOR IMPACT REPORT QUESTION 6

What Are Common Misconceptions About How Students Think and Learn?

For the past several decades, advances in neuroscience have given scientists the opportunity to discover much about how the brain works. This information in isolation has limited potential for positively influencing student learning in schools and yet it holds a promise to do just that. An interdisciplinary partnership between neuroscientists, cognitive scientists, and professional educators has the potential to dispel erroneous myths and multiply the positive effects of researched-based teaching and learning in the classroom. While funds are increasingly being allocated to analyze the functions of the brain (Brain Activity, 2014), this research is only the first step toward potentially shaping teaching and learning in the nation's classroom. Without communicating discoveries in a way that is meaningful to those outside of the neuroscience laboratories, there will likely be no measureable changes in student learning in classrooms. Bridging the gap between the basic science of learning occurring in the isolation of a laboratory setting and in classroom settings by building a common language can better inform both neuroscientists and educators striving to educate children in a complex world. This article proposes neuroscientists, cognitive scientists, and professional educators work together to share, in a meaningful way, their unique perspectives based on their expertise.

The Deans for Impact (DFI) report concludes with the 6th Key Question aimed at dispelling common misconceptions about cognitive principles for student learning. With advances in neuroscience, neuroscientists and educators are being giving the opportunity to form an interdisciplinary partnership to best nurture brain development by investigating previously believed “myths” and critically evaluating information as professionals to meet the needs of students. This section uses critical analysis to address the six cognitive principles noted in the DFI report for Key Question 6 in greater detail to build a case for the importance of forming the interdisciplinary partnership of neuroscientists, cognitive scientists, and professional educators. The cognitive principles shared in Key Question 6 of the DFI report are:

1. Students do not have different “learning styles.”
2. Humans do not use only 10% of their brains.
3. People are not preferentially “right-brained” or “left- brained” in the use of their brains.
4. Novices and experts cannot think in all the same ways.
5. Cognitive development does not progress via a fixed progression of age-related stages. (DFI Report, 2015)

THE LEARNING STYLE THEORY

Cognitive Principle 1: Students do not have different “learning styles.”

It cannot be disputed that individuals express perceived learning styles preferences, and most experienced teachers strive to provide a learning environment that meets the needs of every student’s preferred learning style. However scientific research does not yet support a positive relationship between learning preferences and learning (Pashler, McDaniel, Rohrer, & Robert Bjork, 2008; Riener & Willingham, 2010; Willingham, Elizabeth M. Hughes, & David G. Dobolyi, 2015). Groups of educators, scientists, and researchers define “learning style” differently. In the field of education and for our purposes, we will use the following definition, “the concept that individuals differ in regard to what mode of instruction or study is most effective for them” (Pashler et al., 2008, p. 105). A popular distinction of learning styles is the VAK Model, visual, auditory, and kinesthetic learning styles (Bușan, 2014). According to the VAK Model of learning styles, visual learners would learn most efficiently and effectively when information is presented visually; auditory learners would learn optimally by listening; and kinesthetic learners would, likewise, benefit the most by learning through a hands-on method of instruction. Unfortunately, to achieve the level of validation needed to completely dispel this concept for scientists, randomly assigned groups of learners would have to learn less during episodes from the two styles to which they claim they learn less efficiently. This has not yet been proven and more research is needed to classify this concept as a complete “myth” among educators. According to Bușan (2014) there is no consensus “that teaching according to the learning style can help a person” (p. 104). Other literature reviews support this conclusion (Willingham et al., 2015; Pashler et al., 2009).

The concept of learning styles, especially using the VAK Model, is a broad statement with popular belief and use in the world of education. According to Willingham et al. (2015), this belief may in part be due to several factors:

1. “Social Proof” (Willingham et al., 2015, p. 268). This idea presumes what is read is truth. There are a number of articles and a fairly entrenched volume of materials available for educators targeting differentiated learning styles. Acknowledging learning styles appears to make sense and seems to work in the classroom, so a perception is perpetrated that it must be a true and proven concept. Howard-Jones (2014) reported that over 90% of teachers in five countries (United Kingdom, The Netherlands, Turkey, Greece, and China) believed that their instruction should be personalized to suit different learning styles. While perception among educators appears to be that learning styles exist, research has not yet validated this perception. Riener and Willingham (2000) suggest that while students state that they have preferred learning styles, when tested under controlled conditions, “learning is equivalent” whether they are taught in the stated preferred style or not (p. 33). Thus, scientists call the recognition of learning styles a “myth” while many educators find the approach helpful in the classroom. As Fran Rauscher stated in defense of the existence of a Mozart Effect, “Because some people cannot get bread to rise does not negate the existence of a ‘yeast effect’.” (1999, p. 826)
2. Confusion between ability and learning styles. Individuals may have differing abilities, such as a greater propensity to think mathematically. There has been research suggesting differing “mental abilities;” however, there is limited correlation between forms of instruction and maximizing performance in any one area above others (Pashler et al., 2009).

Current research proposes that educators take into account the student’s aptitude, prior knowledge, and cultural assumptions; not focus on learning styles as the key to successful instruction (Pashler et al. 2009; Reiner & Willingham, 2010; Willingham, Hughes, & Dobolyi, 2015). Educators need to differentiate instruction based on their students’ individual differences; however, the belief that a preferred style of learning for an individual is the best technique for instruction can be costly (Pashler et al. 2009). Cognitive scientists must make this information available to professional educators in a meaningful way. Professional educators need to stay abreast of research and not fall victim to such popular beliefs. However, they should not shy away from “what works” in their classrooms regardless of labels too liberally associated with approaches or strategies.

HOW ACTIVE IS THE BRAIN?

Cognitive Principle 2: Humans do not use only 10% of their brains.

The myth suggesting humans use only 10% of their brains is believed by nearly 50% of teachers in five countries (United Kingdom, The Netherlands, Turkey, Greece, and China) according to survey results reported by Howard-Jones (2014). The origins of this myth may be traced to Albert Einstein’s attempt to explain his own intellect; however, there is also uncertainty as to where or why the myth originated (Boyd, 2008). Myths and traditional beliefs about brain function and activity may be due in part to the brain’s vast complexity. The more we have learned about the brain and how it functions, the more we have found the 10% rule to be untrue. Developments in research and science suggest a very different awareness is within our reach.

Pasquinelli (2011) notes that broadening the knowledge base of brain activity and other brain functions may be enhanced by recent developments in scientific technology such as “fMRI, magnetoencelography (MEG), near-infrared spectrography (NIS), and electroencelography (EEG)” (p. 189). Working together with others, neuroscientists who use brain imaging technology can have a positive impact on a greater understanding of the brain’s capacity. There is already evidence of this progress. Recent research by these scientists has shown us that the brain is even quite active during sleep (Brain Activity, 2014), dispelling an idea that the brain was dormant during sleep. Brain activity and brain capacity are increasingly important topics of neuroscientist research as brain imaging lends greater credibility to related scientific research (McCabe & Castel, 2008). Working with educators, these important findings may translate into some level of application with classrooms.

Because of these developments, grants and other funding is being allocated to better understand the brain and its capacity. One such initiative in the United States, BRAIN (Brain Research through Advancing Innovative Neurotechnologies), is exploring brain activity to better understand how neuron networks function (Brain Activity, 2014). Based on using advanced technology, this current research along with world-wide initiatives such as Human Brain Project, hopes to fill large gaps of understanding of how the complex brain works (Brain Activity, 2014). The currently limited knowledge about the vast and complex neuron networks of the brain is growing. With this growth is coming a deeper understanding of brain functions. Sharing this knowledge in a meaningful way through an interdisciplinary approach to education, scientists and professionals have the opportunity to better nurture brain development and enhance learning.

Boyd (2008) explains the current basic knowledge about the complex functions of areas of the brain including the cerebellum which regulates motor functions, the cerebrum, responsible for higher cognitive functions, and the neurons rapidly firing to consistently communicate and control unconscious activities; however, this is just the tip of the iceberg of brain activities and functions scientific researchers are discovering. Johns Hopkins School of Medicine’s Barry Gordon is quoted as saying (as cited in Boyd, 2008), “It turns out though, that we use virtually every part of the brain, and that [most of] the brain is active almost all the time,” (http://www.scientificamerican.com/article/do-people-only-use-10-percent-of-their-brains/).

While it is true scientific researchers and professional educators still do not know a great deal about the brain, we do know it is a complex and ever-changing organ. An interdisciplinary partnership between neuroscientists, cognitive scientists, and educators will bridge gaps in understanding and help dispel myths and traditional beliefs about the brain such as the “10 percent myth.”

BRAIN LATERALIZATION

Cognitive Principle 3: People are not preferentially “right-brained” or “left-brained” in the use of their brains.

While we know that most people have a dominant hand, eye, and ear, a sweeping statement such as “this student is a right-brained learner” is over simplified and can be misleading. While research supports brain lateralization and specialization of areas of the brain (Matthews, 2000; Nielson, Zielinski, Ferguson, Lainhart, & Anderson,2013; Reuter-Lorenz & Miller, 1998; Rogers, 2014), it does not support brain preference in a holist context. Based on their recent analysis of brain scans from 1011 individuals between the ages of 7 and 29, Nielson et al. (2013) report right- and left- brain lateralization for specific functions such as handedness and classical language; however, specific or localized areas rather than a purely "right" or purely "left" global lateralization was noted. In other words, instead of having a "left- or right-brain global preference," individuals use specific areas of the brain for specific tasks; these areas may be in different hemispheres of the brain. Lateral biases may be a more appropriate term. Rogers (2014) notes lateral biases as activity either "to the left or right depending on the brain region and task" (p. 559).

Right- or left-handedness in primates and humans affects brain function; however, it is not a whole right- or left-sided difference. These generalizations are not a function of solely one side of the brain; research has pin-pointed specific areas of the brain that are active during tasks unique to the individual. As Neilson et al. posit, "areas participate in strongly lateralized connections in both hemispheres" (2013, p. 3); however, areas in both the left- and right-hemispheres communicate and function together. While complexity of the brain continues to be explored with much more to be learned, lateralization and specialization is clearly evident in both humans and animals from the extant literature.

Professional educators need to be aware of individual differences and preferences. Just as a student is typically either right-handed or left handed, she/he may be more inclined to use areas of the brain differently than the learner sitting next to him with the same hand dominance. Research supports the concept that in right-handed individuals a left-hemisphere dominance for language is present as are hemispheric preferences for processes needed for reflection, logic, and problem-solving (Neilson et al., 2013; Rogers, 2014), while these same individuals show a right-hemisphere dominance for attention to external stimuli such as visual spatial ability and emotion (Corballis, 2014). About 70% of left-handed individuals are also known to have a left-hemisphere dominance for language (Corballis, 2014). Whether left-handed or right-handed, individual differences in hemispheric preferences emerge; these can be influenced by external factors. For example, in a study conducted by Rogers (2013), brain lateralization in post-hatched chicks was influenced by visual stimuli to the left or right side of the chick while it developed in the egg. In other words, environmental factors could influence dominance preferences in some situation. Hemisphere preferences exist; however, functions cannot be simplified to global lateralization. Performing tasks requiring multiple brain functions such as solving mathematics problems would require attention to external stimuli and logic. The research suggests humans as well as animals show individual differences in these processes, not necessarily population-level asymmetries (Hopkins, Misiura, Pope & Latash, 2015).

The brain is a complex system of areas of specialization coordinating in cognitive functioning. Neuroscientists examining the brain are better able to pinpoint specific functions and activity in more precise areas of the brain. Neuroscientists, using advanced technology, are gaining greater insight into detailed functions of areas in the brain. Through collaboration with cognitive scientists and professional educators, there are opportunities to enhance development of the brain in the classroom as well as strategies for learning that may be more brain compatible. Instead of relying on sweeping generalizations, professional educators can apply the expanding knowledge of cognitive function to their students' individual differences as they plan their lessons to create a learning environment that more effectively optimizes student learning.

EXPERT V. NOVICE, THE THOUGHT PROCESS

Cognitive Principle 4: Novices and experts cannot think in all the same ways.

Research supports the idea that experts, or those with prior knowledge, approach a learning and/or problem solving task differently than a novice would. Chi, Feltovich, and Glaser (1981) conducted a study to understand the differences between novices and experts when solving physics problems. The results support prior research indicating that experts approach and solve problems qualitatively differently than novices. A salient point in this study is that experts form a scheme or a "basic approach" to problem solving based on prior knowledge (Chi et al., 1981, p. 149).

Glaser and Chi (1988) present findings highlighting key characteristics of experts that differ from novices.

1. Experts are able to perceive a large number of patterns in their area of expertise; whereas, novices may view a limited number at a more concrete level.
2. Experts perform skills and problem solving more quickly and accurately in their areas of expertise than novices.
3. Long-term and short-term memory is greater for experts in their areas of expertise than novices.
4. While novices tend to think at a more concrete level, experts analyze and solve problems at a deeper level.
5. Experts approach problem solving analytically; whereas, novices focus on using an equation or formula to "solve the problem."
6. Self-monitoring skills are greater for experts in their areas of expertise.

Glaser and Chi (1988) compiled these characteristics based on the limited research at the time on artificial intelligence (AI) and later studies focusing on expertise and theories of performance.

More recently, theories related to the development of processes as individuals move from novice to expert focus on metacognition, understanding how one learns. Ross, Phillips, Klein, and Cohn (2005) posit experts can self-monitor and use better metacognitive skills; see problems or errors in a learning/problem solving situation; see patterns and characteristics; and look more analytically at the situation than novices. Providing foundational experiences and taking into account the prior experiences students bring to the classroom should influence instruction which in turn can significantly affect learning.

The accumulation of foundational experiences applies for teacher learning as well. Any school principal can likely pick out the veteran or "expert" teacher and the new or "novice" teacher. It is likely that the more experienced teacher can help translate the new knowledge or learning from the sciences into the learning environment. Neuroscientists, cognitive scientists, and professional educators working together can positively enhance learning experiences of students through dialogue of the scientifically supported understanding of the prior knowledge and the more recent awareness of the effects of meta-cognition on learning and memory. As this research continues to develop, professional educators can rely on the science of learning to better inform their practices.

COGNITIVE DEVELOPMENT, NOT A FIXED-STAGE PROGRESSION

Cognitive Principle 5: Cognitive development does not progress via a fixed progression of age-related stages.

The assumption that all children move through discrete stages of cognitive development that are pervasive across all areas is erroneous (Willingham, 2008). According to Willingham (2008), contrary to the wide belief Piaget's four distinct stages of development and other cognitive stage theories, research over the past 20 years suggests cognitive development is a continuous process that varies based on the individual and the cognitive task. A more accurate description of cognitive development from birth to adolescence is a developmental sequence that is not entirely concrete for all areas. Siegler, DeLoache, and Eisenberg (2003) compare cognitive development to a road map. Individuals experience fits and starts of development, sometimes appearing to regress, other times, making giant progressive steps. There are similar ways to travel from Point A to Point B; however, not all drivers will take identical paths or move at a constant speed.

In a review of the extant literature regarding cognitive development from infancy to childhood, Courage and Howe (2002), found very little research to support "synchronous transitions across cognitive domains" (p. 271). Moreover, research shows a child's behavior indicates movement back and forth between cognitive levels (Fischer & Bidell, 2006). For example, a first grade student may be able to solve a math problem one day; however, the following day he cannot. If cognitive stages were concrete steps, once the stage is reached those abilities accompanying the cognitive development would remain. Synchronous, concrete stages would not allow for this child to be in both stages. Cognitive development is a seamless multi-dimensional movement, not a concrete transition from step to step.

The salient point for educators is the importance of viewing cognitive development as an on-going process that is fostered by providing appropriate instruction, building experiences, and nurturing brain development. By looking at individual differences, using effective instruction, and providing appropriate tasks, educators should recognize that no content is fundamentally developmentally inappropriate (Willingham, 2008). Looking beyond synchronous, concrete cognitive developmental stages, professional educators can focus on providing appropriate foundational experiences, background information, and appropriate methods of instruction for all students.

WHAT ARE THE NEXT STEPS FOR NEUROSCIENTISTS, COGNITIVE SCIENTISTS, AND PROFESSIONAL EDUCATORS?

At a time of great support of and advancements in the field of neuroscience, professional educators, neuroscientists, and cognitive scientists have the opportunity to examine and better understand the functions of the brain to best meet the individual and collective cognitive growth of students in the classroom. Pickering and Howard-Jones (2007) conducted a study of 200 educators, 189 completed surveys and 11 additional participants who were interviewed from a variety of areas around the world, including the United Kingdom, United States, Europe, China and Africa. Results indicate educators have the desire to learn and better understand the brain's role in learning and education. (Pickering & Howard-Jones, 2007). Moreover, educators desire to collaborate with scientific researchers providing input and sharing their perspectives from the practical classroom experience. "It is worth stressing, however, that this survey of teachers' views left us with a clear impression that educators do not want simply to be 'told what works' [Goswami, 2006]" (Pickering &Howard-Jones, 2007, p. 112). Professional educators are the link to the classroom. What are the next steps needed to promote the idea of an interdisciplinary approach to developing the brain?

Koizimi (2004) clarified the concept of forming, what he terms, a trans-disciplinary approach to 'developing the brain' or 'brain science and education' by suggesting bringing together the sciences and the practice of professional education to bridge and fuse the gap between the laboratory and the classroom where the learning can truly be influenced. Professional educators provided with the opportunity to gain clear meaningful scientific information in an effort to modify their prior beliefs and support their educational decision making can positively enhance learning and growth of students in the classroom. Just as neuroscientists and cognitive scientists bring their expertise into the equation, professional educators can join the discussion using their experience and knowledge of the many variables influencing students' learning in the school settings. Neuroscientists and cognitive scientists, with renewed interest and support as well as access to advances in technology, can provide the scientific foundation for dispelling myths, supporting understanding, and developing new theories. An interdisciplinary, or to coin Koizimi's term a trans-disciplinary, approach to improving classroom instruction and learning which includes scientists in communication with professional educators can best meet this goal. Common appreciation, respect, and understanding for bridging science and education can positively affect how the world learns. Our hats are off to support authors of the deans for impact report for providing a platform from which accelerate the launch.

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