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MISCONCEPTIONS

Teachers Can Untangle the Truth from Myth in the Classroom: Using an Interdisciplinary Approach to "Developing the Brain." An Application of Deans for Impact (2015)

Maria Marsella Leahy, Rebecca Shore & Richard Lambert

University of North Carolina at Charlotte

An interdisciplinary partnership between cognitive scientists, neuroscientists, college professors, and professional educators conducting research and implementing best practices in the classroom may potentially enhance the science of developing and nurturing the brain, the science of learning. This article discussed three practical implications: (a) understanding and teaching with learning differences in mind; (b) recognizing student interest and motivation; and (c) assessing and building prior knowledge to influence positive outcomes. In conclusion, examples of current cohort model research and opportunities for collaboration between neuroscientists, cognitive scientists, and classroom teachers are highlighted.

Keywords: brain development, neuroscience, cognitive science, learning

Teachers are constantly searching for best practices to "develop the brain" for the unique students in their classrooms (Koizumi, 2004, p. 440). In science laboratories, advances in neuroscience have given scientists the opportunity to discover much about how the brain works, how to develop the brain. These efforts separately will do little to positively influence our nation's classrooms. An interdisciplinary partnership between neuroscientists, cognitive scientists, and professional educators can bridge this gap multiplying the positive impacts of more researched-based teaching and learning in the classroom. This article proposes practical applications for professional educators in the classroom as well as ideas for building opportunities to forge a relationship with neuroscientists and cognitive scientists to work together to make bring this important research into the classroom.

The Deans for Impact (DFI) report 6th Key Question highlights common misconceptions about cognitive principles for student learning. Key Question 6 of the DFI report shares misconceptions about cognitive principles: (a) learning styles; (b) brain function and activity; (c) brain lateralization; (d) differences in thinking of novices and experts; and (e) fixed progressive age-related stages of cognitive development (2015). Leahy, Shore, and Lambert (2017) address myths and misnomers regarding these cognitive principles. The authors stress the importance of clarification of meaning and avoidance of over simplification and/or overgeneralization of concepts. The purpose of this article is to highlight cognitive principles that are backed by scientific research and provide practical implications for classroom implementation in four areas: (a.) understanding and teaching with differences in mind; (b) recognizing student interest and motivation; and (c) assessing and building prior knowledge to influence positive outcomes. In conclusion of the article, current activities in the field and opportunities for future collaboration between neuroscientists, cognitive scientists, and classroom teachers are presented.

Understanding and Teaching with Differences in Mind

While there is no consensus that matching instruction with learning style preferences positively affects learning (Pashler, McDaniel, Rohrer, & Robert Bjork, 2008; Riener & Willingham, 2010; Willingham, Elizabeth M. Hughes, & David G. Dobolyi, 2015), classroom teachers must take into consideration differences among their students as they plan and implement instruction. Although the notion of specific learning styles and holistic brain lateralization are not currently supported by research, cognitive scientists and educators, however, support learners' differences which affect performance (Riener and Willingham, 2010). Educators who take into account differences in mental capacities, often referred to as talent, ability, or intelligence, can have a positive influence on learning. Because teachers are not generally offered the luxury of teaching and testing each individual student, the whole class must be taught nearly simultaneously. When teaching, understanding differences in mental capacity of individuals in the classroom should be taken into consideration in the planning and implementation of each part of differentiated lessons. Otherwise, educators risk overwhelming some learners while boring others with the same lesson.

When long-term lessons are carefully planned, teachers can take into consideration several important points: (a) the amount of time required of individual students to learn concepts, (b) the depth of understanding needed for individuals, and (c) different modes of presentation needed to create an optimal learning environment. Without generalizing, different modes of delivery that address a variety of "learning styles" such as: visual, auditory, and kinesthetic (Buşan, 2014), may be a more likely way to effectively reach each unique student. For example, if a lesson is taught one way on Day One, possibly 80 percent of the students may learn the concept. For a teacher to attempt to reach the other 20 percent using the same instruction the next day seems reductant and possibly viewed as a poor use of time. Using multiple modes of instruction may more positively affect the learning within the group. Allowing small group instruction, changing the mode of delivery, providing remediation and enrichment activities based on student performance are vehicles to nurture and develop the brain and enhance performance. Many effective teachers avoid methods that limit students' opportunities by blindly believing students have one primary mode of learning differentiating instruction to positively influence learning instead.

Student Interest and Motivation

Individuals with capabilities in different academic areas may also experience greater interest levels and "intellectual energy" in the areas of strength. These affinities play a role as teachers plan and implement instruction in the classroom setting. For example, one student may harbor a greater propensity to think mathematically. He or she, because of his or her ability, may be more interested in the activity, and thus, more motivated to invest the necessary effort and time to be successful. Often a higher propensity to learn in an area can increase interest and performance. Using observations and data to understand individual student abilities, interest, and motivation, teachers have the opportunity to adapt the content and mode of instruction to most effectively influence student learning. Teachers can take into account adaptations such as: (a) expectations of the amount of material a learner is expected to learn; (b) time allotted for students to learn concepts and complete assignments; (c) complexity of activities; (d) type of participation required of the students; (e) type delivery of information; (f) expectations of student performance; (g) the amount of support students need; and (g) individual student goals (Ebeling, 2000).

The adaptations outlined by Ebeling (2000) would most likely change for students based on "mental abilities" in different subject areas. Using the example of "Student M" who thinks "mathematically" compared to a "Student L" who has greater mental capacity for language, teachers can plan instructional activities accordingly. Planning and delivery of instruction to a whole class may include a quick variety of modes of delivery; however, individual guided assignments may be where the teacher can diversify. "Student M" may be introduced to problem solving with the content while "Student L" may be given reinforcement of the content using manipulatives. Diversifying in the classroom requires teachers to customize instruction using their knowledge and understanding of students' individual differences, not solely basing instruction on different "learning styles." Adaptions to instruction based on prior experience and prior knowledge are discussed in the following section of this article.

Research has shown that teachers do make a difference and impact on learning. Teachers can also influence interest and motivation by building a classroom culture which encourages all to learn with a mindset of growth. The understanding and belief that each student can learn and grow has received a great deal of attention from the education research community, and we cannot neglect the difference created by teachers in the classroom (as well as the size of the classrooms) as compared to students tested in a laboratory one at a time.

Assessment of Prior Knowledge and Its Influence on Learning

Neuroscientists, cognitive scientists, and educators support the idea that experts and novices differ in their approaches to thinking and problem solving. Based on research by Glaser and Chi conducted in the 1980's, (1988) highlighting key characteristics of experts that differ from novices. When comparing experts and novices, the thought process and learning process vary in several areas: the level of thought (concrete versus more abstract), speed of processing, levels of working memory, problem solving, and self-monitoring. Differences in prior knowledge influences learning (Riener and Willingham, 2010). Implications for educators in the classroom include understanding individual differences in prior knowledge and the providing foundational knowledge when presenting concepts.

Student "expert" or "novice" status can be determined by assessing prior knowledge. There are a variety of techniques to gather this information. In a review of literature on the effects of prior knowledge Dochy, Segers, and Buehl (1999) report that accurately and appropriately assessing prior knowledge has a strong relationship to performance. Using more objective types of assessment appears to be more beneficial, although more subjective measures have benefits as well. Careful selection of pre-assessment tools is recommended.

Assessments such as portfolios and pre-tests can measure prior knowledge and have been reported to be effective when done correctly (Dochy, Segers, and Buehl, 1999). More recently, self-assessment tools have received attention as a prior knowledge assessment tools. One method, the *Self-Report Knowledge Inventory* (SRKI), showed positive results with secondary and college students in a study conducted by Tamir and Amir in 1981 and Tamir in 1991 (Tamir, 2012). Using a five-point scale, students separately rate their “knowledge” and “skills” their prior experience with a list of concepts that will be taught. Similar self-assessment tools are used with younger students.

Understanding the extent and depth of students’ knowledge and skill prior to entering the classroom is important; however, building a common foundational knowledge base helps students “construct a meaningful mental model” of the material being taught (Neuman, Kaefer, & Pinkham, 2014, p.146). The team’s research which focused on reading comprehension can be related to learning in general. Building background knowledge requires forming networks of understanding. Forming relationships between terms and concepts. In the instructional planning process, teachers can construct opportunities to read, view, and participate in activities that will enhance this process in a positive way. Direct experiences such as hands-on activities are beneficial, but indirect activities which are readily available in the classroom in the form of media and technology can lay a solid foundation as well. Teachers have the opportunity to build a strong foundation of knowledge by implementing well-planned and purposeful activities.

FORMING A TRANS-DISCIPLINARY APPROACH TO BRAIN SCIENCE AND EDUCATION

Teachers are experts in the classroom. Cognitive scientists and neuroscientist are experts conducting research in laboratories. As professionals, each should have a part in improving practices in the classroom. Forming partnerships and fostering clear communication have the potential to help bridge the gap between the classroom and the lab.

Koizumi (2004) used the term, 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 (p. 440). He defines learning as “the process of making neuronal connections in response to external environmental stimuli, whereas education is the process of controlling or adding stimuli, and of inspiring the will to learn” (Koizumi, 2011, p. 48). He adds that learning continues throughout the life’s span and is diverse to each individual. This definition qualifies the need for a partnership between neuroscientists, cognitive scientists and teachers to enhance learning in the classroom. While neuroscientists and cognitive scientists bring their expertise into the equation, professional educators can add to the discussion using their experience and knowledge of the many variables influencing students’ learning in the school settings.

Researchers heading cohort studies are currently leading this movement in Japan (Koizumi, 2011) and may be a model that could be replicated in the United States. The relevance and importance of these cohort studies influences three areas: (a) production of brain science research that may affect policy in areas of child care, K-12 education, and aging; (b) better understanding the effects of technology on the mind; (c) allowing for the testing of hypothesis discovered in studies of the brain conducted on animals to make connections to the human brain (Koizumi, 2011). These cohort studies are currently being conducted in Japan. Table 1 lists and describes several studies related to learning and education discussed in Koizumi's article (2011). These studies are a sample of how the partnership between cognitive scientists, neuroscientists, and education can alter the future of education.

TABLE 1
Cohort Studies Linking Neuroscience to the Classroom

Name of study	Description
'A longitudinal study of twins in infancy and childhood ("TokyoTwin Cohort Project: ToTCoP")' directed by Professor Juko Ando, Faculty of Letters, Keio University (Ando et al., 2006; Ando & Ozaki, 2009; Ando et al., 2009).	This five-year study is to longitudinally follow twins' development using questionnaires and interviews as well as near-infrared spectroscopic (NIRS) imaging. The purpose is to clarify genetic and environmental differences in a variety of cognitive developmental areas.
'A cohort study of autism spectrum disorders: A multidisciplinary approach to the exploration of social origin in atypical and typical development' directed by Dr Yuko Kamio, Division Head of the National Institute of Mental Health, National Center of Neurology and Psychiatry (Kamio, 2007; Kamio et al. 2007; Koyama et al., 2009).	The goal of this research is to develop a database of "developmental trajectory of Autism Spectrum Disorder (ASD)" compared to typical development through analysis of neuron networks and behavioral development. The purpose of this study is to advance understanding of variations of ASD and to enhance early detection and treatment of ASD.
'Cohort studies on language acquisition, brain development and language education' directed by Professor Hiroko Hagiwara, Tokyo Metropolitan University (Hagiwara & Soshi, 2007).	The purpose of this longitudinal study is to determine how second language acquisition affects brain development.
'Cohort study with functional neuroimaging on motivation of learning and learning efficiency' directed by Professor Yasuyoshi Watanabe, Osaka City University School of Medicine.	The results of this research using functional MRI studies may inform educators in the area of motivation and learning fatigue. The study looks at brain functioning of children with learning difficulties to analyze learning motivation.

Note. Adapted from Koizumi, H. (2011). Brain-Science Based Cohort Studies. *Educational Philosophy and Theory, 43*(1), 50-53.

Institutions of higher education have the opportunity to forge an interdisciplinary approach by connecting with teachers and school leaders to development cohorts interested in developing and implement research in the United States. As educators and scientists move toward this goal, development of professional opportunities to share the research that is currently available can be a first step in the efforts of improving practices to nurture and develop each brain in the classroom.

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