REFEREED ARTICLES

Brain-Based Education

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Abstract

Research about the brain has affected the education community and transformed the way that educators think about learning. The field of brain-based education looks at making connections between the latest research findings of neuroscientists and the most effective teaching practices for the enhancement of instruction and learning. Educators who are armed with knowledge of the working system of the brain, and who employ the latest brain-based learning strategies in their instruction, may find themselves to be one step closer in their search for the most effective teaching methods.

For centuries, educators have been searching for information that would guide their practice and assist them in becoming effective teachers. Highly respected educators have developed theories, and scientists have studied the brain. For the past two decades, educators and scientists have worked together, in the field of brain-based education, to determine how the brain functions, in an attempt to enhance teacher instruction and student learning (Spaulding, Mostert, & Beam, 2010). Research about the brain has provided sophisticated theories about how the brain learns. With information regarding brain-based education, educators have been able to guide and adjust their teaching practices to enhance instruction and learning.

The Theory

Many educators have devoted their careers to following the philosophies of some of the top educational learning theorists throughout the years, as they strive to employ the most effective teaching practices. As far back as 400 BCE, Plato cautioned educators against providing students with information without first evaluating their readiness (Willis, 2010). Vygotsky explained that students are able to learn best when they are guided by others, in social situations, to work in their zone of proximal development (Willis, 2010). Learners will be most successful when they are working slightly beyond their current ability level, in low-anxiety situations, according to Krashen and his theory of comprehensible input (Willis, 2010). Another widely accepted theory is Gardner's theory of multiple intelligences, which challenges the idea that every learner is capable of learning the same material, in the same way (Willis, 2010). From ancient philosophy to modern science, it remains evident that to teach effectively is to understand how people learn.

As educators strive to improve learning for all students, it is important that they understand how the brain works. Scientists in the cognitive neuroscience field investigate how the brain works, as they study what happens in the brain as it learns, stores, and uses new information (Van Dam, 2013). To understand how this information about the brain can affect education, experts turn to the field of educational neuroscience. Educational neuroscience is the partnership between the mind (psychology), the brain (neuroscience), and education (pedagogy) (Sousa, 2011). Connecting these disciplines to guide educational practices and policies is the fundamental purpose of this emerging field (Worden, Hinton, & Fischer, 2011). Thus, educational neuroscience is the synergy between what is known about how the brain works and how educators can use that knowledge to improve learning for all students.

Brain-based education has become an exciting topic for educators, as it has the potential to influence their teaching practices. It refers to a specific set of strategies that are used to engage learners and are based on the principles of what experts know about how the brain works

(Jensen, n.d.). Many of the brain-based programs and methods used by educators are based on the latest research findings of neuroscientists (Great Schools Partnership, 2013). Translating these findings into educational practice is the heart of what brain-based education is all about, and it enables educators to employ more effective teaching practices.

Practical Applications

The current brain research has already provided educators with significant information that has practical applications in the field of education. Knowledge of how the brain physically changes after acquiring a new skill has significant implications for learning (Van Dam, 2013), including how the chemicals in the brain can affect learning, and how those chemicals are enhanced by healthy lifestyle choices. The discovery of the brain's ability to rewire and remap itself, or to grow new neurons, has caused educators to rethink many of their previous notions about a person's capacity to learn (Great Schools Partnership, 2013; Jensen, 2008). Among other findings is the improved understanding that social conditions, emotions, and engagement have a greater influence on the brain than was previously thought. These scientific discoveries have made a tremendous impact in the field of education, and educators continue to benefit from this new knowledge about the brain.

Educators can develop more effective practices, based on the brain research, by understanding that the brain physically changes after a person has learned a new skill (Van Dam, 2013). Perhaps even more significant is the understanding that those changes will reverse if the person does not have an opportunity to use and develop that new skill. This information is quite substantial, as it implies that students stand a better chance of retaining the knowledge gained in the classroom if they are provided with opportunities to actually use it. Thus, educators should be encouraged to employ a hands-on learning approach in their classrooms, in which students have frequent opportunities for practice and application of new skills, as a more effective teaching practice.

Educators can use the brain research concerning the chemicals found in the brain and the effect that they have on learning. New knowledge is represented in the brain by generating new connections between brain cells, and the strength of these connections is enhanced by chemicals in the brain called growth factors (Van Dam, 2013). The accessibility of these growth factors can be improved by following healthy routines such as exercise and sleep. This knowledge would lead educators to believe that, with regular exercise and improved sleep habits, students would formulate stronger connections in their brains, thus leading to deeper retention of knowledge. Educators with this knowledge would find it beneficial to engage their students in regular physical activity and to promote healthy lifestyle choices, in an effort to enhance the chemicals in their brains and positively affect their learning.

The discovery that the brain can change and rewire itself has drastic implications in the field of education. Neuroplasticity is the concept that connections in the brain can be changed and reorganized over time as people "learn new concepts, have new experiences, or practise certain skills" (Doidge, 2007, p. xix; Great Schools Partnership, 2013, "Reform," para. 1). Knowledge of these changes is very significant for educators, as they understand that the networks in the brain can construct stronger connections, resulting in more efficient networks and enabling the learner to have lasting, long-term memories (Willis, 2010). As students learn new concepts, they are making connections between this new information and their "existing patterns of stored information" (Willis, 2010, p. 61). Thus, experience has a profound influence in shaping the brain, because the more experiences students have, the more opportunities they will have for their brains to connect and link new experiences to previous ones (Chita-Tegmark, Gravel, Serpa, Domings, & Rose, 2012). As students practise their skills and review their knowledge over time, they are building stronger connections in their brains (Jensen, n.d.). Practice and review are important components of the learning process, because "there is almost no transfer to long-term memory without rehearsal" (Sousa, 2008, p. 52). Accordingly, a new adage is

emerging: practice makes permanent. Educators who understand the ability of the brain to rewire and remap itself frequently provide their students with new experiences and opportunities to make connections, and constantly review new content with their students, in an effort to build stronger connections in their students' brains.

Brain research shows that the brain has the ability to grow new neurons, and that these new neurons are "highly correlated with memory, mood, and learning" (Jensen, 2008, p. 411). This information is particularly relevant to educators because the process of growing new neurons can be regulated and enhanced by exercise, diet, and low stress levels. Educators can support the growth of new neurons in their students by planning a variety of physical activities, including scheduling frequent movement breaks, incorporating good nutrition into school practices, and decreasing the stress levels in their students (Cozolino, 2013; Jensen, n.d.). Thus, learning can be positively or negatively affected by the quality of lifestyle choices made, and educators contribute to improving students' memory, mood, and learning by encouraging and promoting healthy lifestyles.

Stress can be a very concerning issue for students, as high stress levels can affect their "memory, social skills, and cognition" (Jensen, 2008, p. 411). Stress and trauma in early childhood can cause the release of a stress hormone called glucocorticoid, which causes substantial changes in the hippocampus, affecting the brain's ability to learn new information and form long-term memories (Doidge, 2007). In addition, neuroimaging shows that the brain has a reticular activating system (RAS) filter and that this filter acts as an intake system in the lower brain stem (Willis, 2010). Sensory input must pass through this filter in order to be received by "the higher brain" (Willis, 2010, p. 49). During stress or fear, the RAS filter will give preference to the input that is considered relevant to the perceived threat, instead of to the information that the individual is trying to learn (Willis, 2010). Therefore, students who experience continuously high levels of stress are likely to have long-term consequences (Fischer, 2012). In an effort to lower the stress levels of students, educators should consider fostering a nurturing environment, complete with movement, drama, and celebration (McCall, 2012), as well as including stress-management techniques into their daily practice (Cozolino, 2013). It is extremely important for educators to consider and monitor the stress levels of their students, in order to maximize learning in their classrooms.

The brain is highly affected by social conditions, and this realization has become more significant with the discovery of a special class of brain cells called mirror neurons (Jensen, 2008). These neurons are unique, as they "fire not only when an individual performs an action, but also when the individual observes someone else make the same movement" (Perry, 2013, para. 3). Prior to this discovery, many scientists thought that "brains use logical thought processes to interpret and predict other people's actions" (Perry, 2013, para. 4). Scientists now believe that it is people's feelings that help them to understand one another, rather than their thinking. This information is relevant for educators, because school is a highly social place, full of highly social experiences, and these experiences help to shape the students' character and develop their feelings of acceptance (Jensen, 2008). As a result, educators should be cognizant of social groupings, and be deliberate in the way that students are grouped, rather than rely on random social groupings that might be isolating or defeating to some students (Jensen, n.d.). Educators need to realize how significantly students are affected by their social conditions, and more consideration needs to be given to how much control and power students have over their own social environments.

New brain research has established connections between emotion and memory, which has significant impacts on education (Van Dam, 2013). Students are more likely to remember their experiences when they are connected to emotions, because their emotions "alert the brain's attention systems" (Sousa, 2011, p. 40). Dopamine is a "learning-friendly neurotransmitter" that has a significant influence on learning (Willis, 2010, p. 54). Increased levels of dopamine stimulate more pleasurable emotions and improve students' memory, focus, and motivation. In addition, students' dopamine levels rise with their positive emotions and drop with their negative

emotions. Thus, students learn better when they are experiencing pleasurable emotions. Many teaching strategies are associated with increased levels of dopamine, including opportunities for student choice, investigations that are driven by the students' interests, collaborative group activities (Willis, 2008), and frequent laughter breaks (Tate, 2010). By creating a positive emotional climate, educators can ensure that their students are provided with the most conducive environment for learning.

From brain research related to engagement, scientists have come to understand that engagement is a prerequisite for learning. The brain's RAS is particularly receptive to sensory input that triggers curiosity and "alerts the RAS to pay attention because something has changed" (Willis, 2010, p. 50). Educators can nurture curiosity in their classrooms by promoting student engagement. Students who struggle with engagement may find success with the use of technology (Jensen, 2008). Game playing, for example, is linked to increased levels of engagement, along with the added benefits of quicker information processing and improved ability to identify important material (Miller & Robertson, 2010). Novelty is another highly successful strategy used by educators to facilitate curiosity and engagement, because the brain is attracted to new information (Tate, 2010). Ensuring student engagement by arousing curiosity should be a focus for educators, because students are more likely to remember what they are learning when they are actively engaged. Whether educators choose to use technology to promote engagement, or one of many other practical applications, this new information, from the current brain research, has provided them with the tools necessary to affect their teaching practices in positive ways.

Conclusion

Educators have always searched for effective ways to teach their students, and throughout the years, learning theorists have offered their views. Recently, the fields of education and science have merged in an effort to shed some light on this topic. A new field has emerged, known as brain-based education, which suggests that "without knowing the working system of the brain, it is not possible to understand the nature of learning" (Duman, 2010, p. 2080). Brain research demonstrates that the brain has the ability to change itself as new information is learned. Research about the brain also suggests that people have the ability to affect the way in which they learn, by making healthy lifestyle choices that are essential for raising the good chemicals in the brain, rewiring the brain to make more efficient connections, and growing new neurons. Students can benefit when educators apply a variety of instructional strategies that are strongly correlated to improving student learning through low-threat environments, positive social situations, mood regulation, and engagement. Educators will continue to search for the most effective teaching methods, and with brain-based education they may be one step closer to finding their answers.

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