The Principles of Brain-Based Learning and Constructivist Models in Education

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Abstract

In recent years, the use of electrophysiological studies, neuropsychological tests and imaging techniques, providing opportunity for the researchers to study the brain both structurally and functionally, have provided considerable amount of knowledge, which resulted in important changes in educational areas. During this period, through the impact of constructivist approach, three significant concepts have come into prominence: "Individual differences", "contextuality" and "complexity". In this regard, an important part of educational studies has focused on understanding the learner with his/her differences, complexity and wholeness within a sociocultural context. Similarly, brain studies have provided important new framework for rethinking about the educational studies and learning models. Considering these three concepts (i.e. "individual differences", "contextuality" and "complexity), the present review tries to analyze the outcome of the brain research, to discuss the principles of Brain-Based Learning with the possible consequences and implications on education and, in the light of Brain-Based Learning principles, to evaluate the constructivist learning models such as Experiential Learning, Multiple Intellengience, Collaborative Learning, Self-Regulated Learning.

Key Words

Brain-Based Learning, Constructivist Models, Hemisphericity, Assessment, Emotion

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The Consequences of Neuroscience Studies on Educational Area

Since the idea of "information storage by the modification of interneuronal connections" proposed by Cajal, and the "experience-dependent synaptic strengthening" postulated by Hebb, a large amount of research regarding the physiology of memory and learning have been carried out. Although the whole picture about the understanding of how experience gets into the brain, how the brain organizes itself to get, remember and forget the knowledge cannot be clearly demonstrated, one of the mostly known contemporary theoretical formulations of learning and memory is based on the plasticity of the neurons (sprouting of new axons and dendrites, and new synapses). Throughout life, the brain constantly "re-constructs" itself in order to cope with ongoing changes, and meet the ever-changing demands, the cognitive, behavioral and emotional status of an organism is remodeled by this lifelong self-adjustment and self-optimization processes. In rodents, non-human primates and humans, the experimental studies based on enriched environmental conditions, social deprivation and stress indicate that the functional and structural changes (permanent or stable changes) are seen not only in the developmental stage, but are also in throughout life. For example, while enriched environment reduce the rate of spontaneous apoptotic cell death later in life and protect against age-related decline of memory function, social deprivation or stress, on the contrary, is associated with an increased rate of apoptosis in the hippocampus and a reduced rate of neurogenesis in adulthood (for review, see Gülpınar & Yeğen, 2004; Kolb & Whishaw, 1998).

Considering the functional organization of the brain, many concepts, hypothesis, and models have been developed since the mid-nineteenth century. The efforts to characterize the functional organization and functional differences among different brain regions, particularly between the two hemispheres of the human brain, have been a central theme in the cognitive neurosciences. As the information about structures and function of brain increased, concepts and models that is related with function and organization of the brain have changed from ‘‘hemispheric dominance’’, that was used to refer the language laterality of the brain, to ‘‘cerebral asymmetry’’ (non-language dominance differences, task-dependent differences) and ‘‘hemisphericity’’ (the predominance of one hemisphere and one hemispheric mode of processing, i.e. verbal-analytical processing mode of left cerebral hemisphere and a nonverbal-holistic processing mode of right cerebral hemisphere, regardless of the type of task; Morton, 2003b). In this context, many brain and learning research have indicated that each hemisphere was specialized for a particular type of information-processing and certain human cognitive functions depend predominately on either the left or right cerebral hemisphere of the brain. In other words, the two cerebral hemispheres of the brain are specialized for two different modes of conscious and two different modes of knowing about the world (here-and-now experiential orientation of right cerebral hemisphere and the there-and-then theoretical orientation of left hemisphere; Kolb, 1984). A number of research have demonstrated that the left cerebral hemisphere operates in a linear, sequential manner with logical, analytical, propositional thought. On the other hand, the right cerebral hemisphere operates in a nonlinear, simultaneous fashion, deals with non-verbal information and appositional thought. The right hemisphere appears to process information more “holistically,” with the ability to form a mental representation of the whole, while the left hemisphere breaks down information into its components; the left cerebral hemisphere is specialized to process only one stimulus at a time, in a sequential, logical, and linear manner, whereas the right hemisphere can process a whole cluster of stimuli at the same time (Ornstein, 2004). In general, the left hemisphere appears to be a language -and future-oriented with abstract cognitive approach, whereas the right hemisphere is feeling/experience- and present-oriented with concrete experiential approach (Kolb, 1984).

Lastly, regarding the learners’ differences and learning styles, it could be said that theoretical basis of learning style and functional organization of left and right cerebral hemisphere have been co-developed. An abundance of literature has indicated that an individual’s brain hemispheric processing mode, i.e hemisphericity, is directly related to that individual’s learning style. Therefore, hemispheric specialization and the resultant learning style have significant implications for learning and teaching. In these regards, in order to promote constructive friction, or at least for congruence and for avoiding destructive friction between learning and teaching; the importance of knowing learners’ hemisphericity and learning styles were understood and efforts to design brain-compatible constructive instruction have been increased (Vermunt & Verloop, 1999; Vermunt, 1995, Caine & Caine, 2002).

Brain-Based Learning and Constructivist Learning Approaches / Models In Education

As mentioned before, neuroscience studies have provided a new framework for rethinking about learning and teaching. In consequence, Caine and Caine's Brain / Mind Learning, McCharty's The 4MAT System, Hart's Brain Compatible Learning, Edwards & Sparapani's Thinking / Learning System, Herrman's Whole Brain Teaching have been appeared as Brain-Based Learning models / approaches. Also, neuroscience and cognitive neuroscience have provided theoretical basis for other learner-centered and constructivist approaches/models such as Experiential Learning, Multiple Intelligence, Cooperative Learning, Self-Regulated Learning (Caine & Caine, 2002; De Boer, 2001; Kolb, 1984; Sparapani, 1998).

The assumption behind Brain-Based Learning and Brain-Based Assessment is that research in neuroscience should guide learning and assessment. On the basis of brain and learning research, e.g. by Caine & Caine (200), 12 principles of Brain-Based Learning were listed (Table 1) and considering these principles, three fundamental, and in fact not separable, elements of optimum teaching were described as follow:

1. Relaxed Alertness, which means, creating the optimal emotional and social climate (challenging, but non-threatening, and confirmative environment with complex social interactions) for learning.
2. Orchestrated Immersion in Complex Experience, that is, creating optimal opportunities for learning by providing learners rich, complex, and realistic experiences; giving learners time and opportunity to make sense of their experiences by reflecting, finding, and constructing meaningful connections in how things relate and, during the whole process, by presenting efficient tutorial.
3. Active Processing of Experience: Creating optimal ways to consolidate learning, i.e., continuous active processing of ongoing changes and experiences to construct, elaborate and consolidate "mental models/patternings"

As a parallel to this optimal learning environment, assessment approach has also changed into more a complex and holistic manner. In order to assess the learner's performance during picturing the concepts, experimenting with idea, constructing mental models/patternings, combining necessary knowledge and skills to solve complex problems, planning and managing their learning process, reflecting on their work and adapting and integrating learning, brain-based assessment has been developed as a performance-based, authentic assessment (Caine & Caine, 2002; Sparapani, 1998).

Table 1
Twelve Principles of Brain / Mind Learning (Caine Learning Institute, 2005)

1.	All learning engages the entire physiology
2.	The brain/ mind is social
3.	The search for meaning is innate
4.	The search for meaning occurs through patterning
5.	Emotions are critical to patterning
6.	The brain/mind processes parts and wholes simultaneously
7.	Learning involves both focused attention and peripheral perception
8.	Learning is both conscious and unconscious
9.	There are at least two approaches to memory (rote learning system, spatial/contextual/dynamic memory system)
10.	Learning is developmental
11.	Complex learning is enhanced by challenge and inhibited by threat associated with helplessness and fatigue
12.	Each brain is uniquely organized

Regarding these 12 principles of Brain-Based Learning and three elements of Brain-Based Teaching, constructivist approaches / models such as Experiential Learning, Problem-Based Learning, or Cooperative Learning can be evaluated as a brain-compatible as much as, e.g., they respect learners as a unique individual with their socio-cultural context; build trust, safe, confirmative, non-threatening, but challenging environment for learners, create an enriched complex learning environment, provide meaningful realistic experiences, offer choices in activities, give learner time and opportunities to process and reflect on what they are experiencing and learning, etc.

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