

# Chapter 1.40

## Brain-Based Learning

**Kathleen Cercone**

*Housatonic Community College, USA*

### ABSTRACT

Neuroscience research that explains how the brain learns is a dynamic field. Since the 1990s, there has been explosive growth in information about the neurophysiology of learning. A discussion of the neuroanatomy that is necessary to understand this research is presented first. Following the discussion of anatomy and physiology, current brain research is described, with particular focus on its implications for teaching adult students in an online environment. In addition, two instructional design theories (Gardner's multiple intelligence and Kovalik's integrated thematic instruction) that have a basis in neuroscience are examined. Recommendations founded on brain-based research, with a focus on adult education, follow, including specific activities such as crossed-lateral movement patterns and detailed online activities that can be incorporated into an online learning environment or a distance learning class (and face-to-face classroom) for adults. Comprehensive recommendations and guidelines for online

learning design have been provided as suggestions for making maximum use of the brain-based principles discussed in this chapter.

### INTRODUCTION

Neuroscience research findings are now scientifically confirming many learning theories first introduced during the educational reform efforts of the 1960s (Lackney, n.d.). Researchers have explored many different aspects of the brain, including anatomy, circulation, electrical activity, glucose metabolism, and neuronal growth. Even with the growth of scientific information, the human brain is, for the most part, still unknown, as the brain is extremely complex. The brain is the major controller of the body, similar to a computer's CPU (central processing unit). It is the information processor of the human body. The brain is capable of multitasking, and it "assembles, patterns, composes meaning, and sorts daily life experiences from an extraordinary number of

clues” (Jensen, 2000, p. 12). The brain, in addition to being extremely complex, is a dynamic and adaptive system. The brain contains hundreds of billions of neurons and interneurons that produce an enormous number of neural nets, or groups of neurons working together, from which our daily experience is created (Lackney, n.d.).

The brain’s activity is controlled by genetics, development, experience, culture, environment, and emotions, and it is constantly under stimulation to change (Gardner, 1999). Since the 1980s, significant scientific findings have emerged about how learning occurs. By the 1990s, the scientific community had started to increase dramatically with new information about the brain. Developments in technology have allowed researchers to see inside the brain, and visualize how the structures in the brain communicate. Common imaging techniques used by researchers include computerized axial tomography (CAT, or computerized X-rays), functional magnetic resonance imaging (fMRI), and positron emission tomography (PET). These tools have allowed scientists to learn more about the brain, and findings made through them are influencing the worlds of education, science, and medicine.

With advances in technology and knowledge about the brain, there has been the development of brain-compatible or brain-based learning. Brain-based learning is a new paradigm that has tremendous implications for educators and students. This chapter will define brain-based learning, and will provide an overview of the anatomy, brain chemistry, neuronal connections, and current neuroscience research that are important in understanding how learning occurs. Neuroscience research needs to be translated into brain-based learning strategies that can be used by educators, and instructional design theories need to be developed in response to the new brain-based information being discovered by scientists. These theories should attempt to translate the neuroscience research, and provide methods that helped educators to develop instructional strategies.

Following this discussion, recommendations will be made for the design and development of a distance learning or online course.

## **THE BIOLOGY OF LEARNING**

According to Jensen (2000), brain-based learning is “learning in accordance with the way the brain is naturally designed to learn” (p. 6). Research about how the brain learns is being conducted across several disciplines, including psychology, neuro-anatomy, genetics, biology, chemistry, sociology, and neurobiology (Jensen, 2000). Brain-based learning is biologically driven, and the conclusions developed to date have not been definitive. Research continues, and our understanding of brain-based learning will be subject to future changes. The brain-based learning approach is not a recipe for all learning, but it can be used to develop strategies that are based on the current available research.

### **BRAIN ANATOMY, CHEMISTRY, STRUCTURE, AND BODY CONNECTIONS**

To understand how the brain learns, a basic understanding of the anatomy and physiology of the brain is necessary. The largest portion of the brain is called the cerebrum. The cerebrum is the most highly evolved part of the brain, and is sometimes called the neocortex. Higher order thinking and decision making occurs here. The cerebrum is composed of two hemispheres that are connected by a neural highway, the corpus callosum. Information travels along the corpus callosum to each hemisphere so that the whole brain is involved in most activities. Each cerebrum is composed of four lobes: frontal, parietal, temporal, and occipital. Each lobe is responsible for specific activities, and each lobe depends on communication from the other lobes, as well as

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