Chapter 2
Neuro-Informed Learning: The Next Frontier

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ABSTRACT

As the epicenter for learning activities, the brain is the coordinator of all actions associated with collecting information, organizing it, storing it, and eventually re-organizing it for application in the real world. And yet, to date, little has been known about what happens within the brain during learning activities. We have operated based on a black box set of assumptions that results in researchers testing inputs and outputs but lacking a true understanding of what happens between those two endpoints. However, the fields of neuroscience and cognitive science, along with neuro-technology engineers, have simultaneously been studying the brain and developing apparatus that allow us to understand what is happening in the brain in real-time during learning. The implications of these capabilities and a deeper understanding of learning are boundless. Accordingly, this chapter will delve into four key areas: (1) research and theories, (2) cognitive readiness and comprehension, (3) neuro-technology data, and (4) the necessary evolution of teachers to facilitators.

DOI: 10.4018/978-1-7998-8032-5.ch002

INTRODUCTION

As the epicenter for learning activities, the brain is the coordinator of all actions associated with collecting information, organizing it, storing it, and eventually re-organizing it for application in the real world. And yet, to date, little has been known about what happens within the brain during learning activities. We have operated based on a black box set of assumptions that results in researchers testing inputs and outputs but lacking a true understanding of what happens between those two endpoints. However, the fields of neuroscience and cognitive science, along with neuro-technology engineers, have simultaneously been studying the brain and developing apparatus that allow us to understand what is happening in the brain in real-time during learning. The implications of these capabilities and a deeper understanding of learning are boundless. Still, preparation for how this knowledge will change the way education and training are developed, delivered and how learners will regulate their own learning experiences will need to evolve. Accordingly, this chapter will delve into four key areas: (1) Research and theories; (2) Cognitive readiness and comprehension; (3) Neuro-technology data and what we can learn from it; and (4) the necessary evolution of teachers to facilitators and the development of personalized learning pathways. Ultimately, this chapter aims to provide the reader with a vision of the future of learning that will be informed by highly complex, real-time neuro-data that will allow learning experiences to be personalized to learners' needs, capabilities, emotions, and goals.

NEURO-COGNITIVE RESEARCH AND THEORIES

What Have We Learned, and How Have We Organized That Information for Application to Learning Structures?

2000-2010

Prior to 2010, the majority of neuro-informed learning research was supported by the Office of Naval Research (Walcutt, Horton, Jeyanandarajan, & Yates). The goal was to determine how the brain can intake, process, and apply information effectively and efficiently. Simultaneously, they supported the investigation of real-time cognitive monitoring during learning to determine how the brain operates during decision making under stress, learning complex systems, and applying knowledge in real-world settings. Ultimately, the hope was to define the most optimal pathway for information to enter working memory, travel to long-term memory, and then be retrieved, translated, and applied meaningfully. With greater insight into the brain and its functioning, real-time adjustments to training and education programs could be achieved. The combination of technology and learning science was beginning to make possible optimized learning experiences without over-taxing the human mind (Snyder, 1989; Eisenhardt & Zbaracki, 1992; Zsambok & Klein, 2014; Crichton & Flin, 2017; Flin, Salas, Straub, & Martin, 2017). However, early data, though promising, also included significant "noise."

For example, in the early 2000s, one of the first large-scale programs in the area, the Augmented Cognition program, combined multiple different neuro and physiological sensors that helped define the art of the possible (Schmorrow & Kruse, 2002). The focus of this project was to improve the reliability of measuring learner state, workload, and cognitive changes during learning. While the significant series of studies moved the research forward, a number of concerns and issues were noted: 1) the technology

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