Editorial: Volume 32 Issue 6

Special Issue: Brain, mind and educational technology

There has been substantial hype around the growing body of research investigating how learning occurs in the brain. Over the last century, in particular, we have learned more about how the brain functions than has been discovered throughout history (Albright, Jessell, Kandel & Posner, 2000). New imaging techniques, such as electroencephalography (EEG) and functional magnetic resonance imaging (fMRI), have been pivotal in driving this research agenda. The emergence of the field of cognitive neuroscience has further helped to align foundational work on uncovering how the brain works with what is known about learning from the psychological sciences. In combination with education, new fields such as 'educational neuroscience' have emerged with the aim of translating the findings from the laboratory to the classroom (e.g. Ansari, Coch & De Smedt, 2011).

One of the main drives behind the emergence of the field of educational neuroscience is the seductive promise that neuroscience will provide educators with truths about learning that they can apply to practice. The thought is that our evolving understanding of the brain will lead to fundamental, scientific insights that will, in turn, lead logically to improvements in education. For example, research in neuroscience is revealing how attention (e.g. Posner, 2004) and working memory (e.g. Baddeley, 2003) occur in the brain. With this understanding, it is possible to consider how these fundamental cognitive processes impact on how students are able to acquire knowledge. With the intertwining of neuroscience and fields such as education, psychology and the learning sciences, researchers are increasingly considering learning holistically 'from the neuron to the neighbourhood'. In other words, it is possible now to investigate fundamental patterns in learning that link classroom and digital educational settings, individual learning and the underlying psychological and physiological correlates.

Despite the potential neuroscience brings to research and practice in education and with educational technologies, there is some way to go for this potential to be realised (Lodge & Horvath, 2017). Neuroscience and psychological science are conducted in highly controlled settings allowing for the direct manipulation of individual or contextual factors to determine cause and effect relationships. It is difficult to make inferences from these controlled laboratory environments to noisy, complex physical or virtual classrooms. Following on from the work of Allen Newell (e.g. 1990) in the area of intelligent tutoring systems, Anderson (2002) labeled this the 'seven orders of magnitude' problem. A study conducted on small parts of the brain over timespans of milliseconds or less (as is common in brain imaging studies) is orders of magnitude away from the reality of educating scientists, professionals and scholars, a process that takes many years. Translating from the laboratory to higher education (and back again) is therefore not as simple as taking the results of a brain imaging study and applying them directly in practice. Many steps need to be undertaken in between (Horvath & Lodge, 2017).

The purpose of this special issue is to start to unpack these steps. The articles in this issue provide examples of studies where the laboratory and educational technology can find common ground. The issue is intended to be forward looking in this respect. The challenge of translating research from the laboratory to useable principles for practice in educational technology is not easy. This difficulty is partly evident in the number of papers in this issue. While we received quite a few submissions, many of them were not able to address the core theme of the issue. The relatively small number of papers we have in the issue therefore represents the difficulty of the endeavor but also presents an opportunity to the educational technology community. There remains much work to be done to work out how to apply what is being discovered about learning in the brain and mind to practice with educational technologies.

The papers in the special issue reflect the diversity in the ways in which researchers and practitioners go about the difficult translation process. The first paper by Marzouk and colleagues discusses the important role that learning analytics can and should play in the development of the link between the science of learning and educational technology. The paper includes an exploration of six areas or cases where learning analytics may help to promote student motivation through self-regulation and self-determination.

Like self-regulated learning, another theoretical construct that has been tested extensively in the laboratory is cognitive load. In the second paper by Kruger and Doherty, educational video is analysed through the lens of cognitive load theory. Kruger and Doherty explore the options for a multimodal assessment of cognitive load using video, including the use of EEG, eye-tracking and psychophysiology.

In the third paper, Diana Laurillard presents work on dyscalculia and digital games. The implications of studies examining the use of games to help students develop ‘number sense’ for higher education are discussed. The paper introduces issues around the creation of resources for supporting students who might fall behind due to difficulties such as dyscalculia and dyslexia; conditions that are becoming better understood through brain imaging studies.

The final two papers report on how eye-tracking can be used as a means of determining student progress in digital learning environments. Wong, Moss and Schunn examine reading strategies with pupillometry. Relying on pupil diameter as a marker of self-explanation, they found differences according to the type of strategy used while reading. Pachman et al. examined gaze-tracking patterns to detect when learners become confused while trying to solve complex problems. Both of these papers highlight how psychophysiological measures such as eye-tracking can be used to provide insight into processes underlying learning in digital environments.

The articles that make up this special issue provide a small sample of the possible approaches that may be used to bridge neuroscience, experimental psychology and practice in educational technology. It is perhaps telling that there is little mention among the articles of brain imaging techniques such as fMRI. Again, this highlights the difficulty in applying the results of imaging studies to the complex task of designing instruction that incorporates educational technologies (see Dalgarno Kennedy & Bennett, 2010).

While the difficulties in applying what we are learning in the laboratory to the classroom (physical or virtual) are indisputable, the articles in this special issue demonstrate that attempts to bridge the gap are beginning to take shape. We hope that this special issue will serve as a catalyst for further work at the intersection of the science of learning and educational technology. It is through this collaborative and translational work that researchers and practitioners in education and educational technology will build a more holistic understanding of the links between the brain, the mind and educational technology.

Special Issue Editors
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