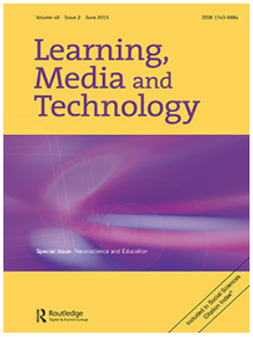

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Introduction to *Learning, Media and Technology* neuroscience and education special edition

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> Only by understanding how the brain acquires and lays down information and skills will we be able to reach the limits of its capacity to learn. (Blakemore and Frith 2005)

The relevance of neuroscience to education and its potential impact on pedagogy is increasingly being recognised by scientists, educationalists and policy-makers. Our thoughts, perceptions and actions continuously change the strength of connections between neurons in the brain, such that these physical connections come to represent our understanding and knowledge of the world around us, so-called *brain plasticity*. Education, therefore, plays a crucial role in shaping the shifting balance of strengthening and weakening of connections in the brain (Ansari and Coch 2006). Indeed, it has been argued that teachers are the only professionals required to change brain connectivity in young people on a daily basis!

At the same time, significant insights are being revealed about developmental stages (e.g., early-years, adolescence), the impact of environmental factors on the brain (e.g., nutrition, sleep, exercise) and the processes by which the brain acquires essential learning skills and abilities such as memory, attention, motivation, numeracy and literacy (Blakemore and Frith 2005; Goswami 2006; Howard-Jones 2013; Meltzoff et al. 2009; Royal Society 2011).

The growing body of scientific research into the nature of learning and education is matched by the enthusiasm of many teachers to incorporate this understanding into their experience and expertise (Pickering and Howard-Jones 2007). Yet despite this enthusiasm, and the immense potential for interdisciplinary collaboration between neuroscience and education, there has traditionally

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been little dialogue between these fields (Howard-Jones 2013). As result, there are too few insights from neuroscience research informing and supporting education practice, and insufficient input from teachers into the design of educationally relevant research in the laboratory (Ansari and Coch 2006; Goswami 2006; TLRP 2006).

One consequence of this limited interaction between neuroscience and education is that there have been an increasing number of products and ideas permeating into education predicated on unfounded scientific and educational claims such as 'Left/right brain thinking' and 'BrainGym' (Dekker et al. 2012). Without an effective knowledge base on which to draw to appraise such technologies and ideas, many teachers feel vulnerable to being told what works from a position of unchallenged scientific authority (Pickering and Howard-Jones 2007).

Against this background, there is a growing call to deliver cross-disciplinary initiatives that develop and assess teaching methods generated from translating the latest scientific research to classroom practices (Ansari and Coch 2006; Goswami 2006; Howard-Jones 2013; Royal Society 2011). Two types of multidisciplinary approaches have been highlighted as being crucial to progress:

- laboratory studies that investigate the effect of different educational methods on the functional and structural organisation of the brain;
- classroom-based studies that develop and access teaching methods drawn from existing neuroscience insights.

So, how to proceed? The only effective way is through a balanced dialogue between scientists and educators, drawing upon the knowledge and expertise within each group. This approach empowers educationalists without devaluing established good practice that is yet to be supported by science.

Unfortunately, such cross-disciplinary work has been traditionally difficult to fund, often falling between the responsibilities of education and scientific funding bodies. Encouragingly, an exciting funding scheme led by the *Education Endowment Foundation* and the *Wellcome Trust* in the UK shows considerable promise in this area. Up to £6 m has been allocated to develop, and test, some of the most promising educational interventions that are based on the latest neuroscientific understanding. The projects will build on the existing evidence about effective teaching and learning practices, and demonstrate how these practices can be improved using insights from neuroscience. Crucially, for the first time at significant scale, projects will be evaluated using experiment trial methodology (e.g., randomised controlled trials) to investigate the impact on pupil attainment, especially that of disadvantaged pupils.

A number of projects in this funding round are investigating themes covered in this special edition. A project led by Russell Foster, at University of Oxford, will investigate the impact of shifting the start time of the school day on teenagers' educational achievement. Paul Howard-Jones, an author of two papers in

this special edition, will investigate the use of software based on the principles of uncertain reward in the classroom. Other projects include exploring the application of 'Spaced Learning', where learning exercises are spaced with non-learning tasks, and Usha Goswami's project to develop phonological awareness through 'rhyme analogy'. Collectively, this cross-disciplinary research and development promises to build a better understanding of the potential for applying neuroscience in the classroom.

This special edition on Neuroscience and Education demonstrates other new approaches in the field. The importance of common conceptual frameworks and discourse is clearly vital and, at times, has been problematic. Busso and Pollack (No brain left behind: consequences of neuroscience discourse for education) explore these complexities at the intersection of neuroscience and education. Carrasco, Serrano and Garcia (Plasticity as a framing concept enabling transdisciplinary understanding and research in neuroscience and education) explore the potential of plasticity as a central link between education and neuroscience communities. The complexities of bringing together radically different research methodologies are explored by Antonietti, Colombo and Di Nuzz (Metacognition in self-regulated multimedia learning: integrating behavioural, psychophysiological and introspective measures), where a combined approach reveals more than an education or neuroscientific perspective on its own.

There is no doubt that advances in neuroscience in the next decade will challenge current educational practices. This is to be expected given the enormous investment in neuroscience already committed by governments globally. Yet the potential benefits have to be actualised, and benefit real students in schools and universities. This will require a co-operative, multi-disciplinary approach. We hope this special issue may indicate how such multi-disciplinary approaches may be valuable.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Jonathan previously worked at The Institute for the Future of the Mind at the University of Oxford, where he was looking at how insights from brain-science research can help support teachers' expertise and professional development. Prior to this he worked as a secondary school science teacher in Sydney. He is the author of Evidence for the

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