## 'Lost in translation'-Where 'what works' doesn't work

Jason M. Lodge University of Queensland jason.lodge@uq.edu.au













#### **Collaborating Organisations**



















#### **Partner Organisations**



















## What works?

How do we translate it?

#### Expanded Edition

## How People Learn



Brain,

Mind,



Experience,



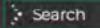
and

School

NATIONAL RESEARCH COUNCIL









#### Select topics to Find What Works based on the evidence



Literacy



**Mathematics** 



Science



**Behavior** 



Children and Youth with Disabilities



English Learners



Teacher Excellence



Charter Schools



Early Childhood (Pre-K)



Kindergarten to 12th Grade



Path to Graduation



Postsecondary

#### WELCOME TO THE WHAT WORKS CLEARINGHOUSE

The What Works Clearinghouse (WWC) reviews the existing research on different programs, products, practices, and policies in education. Our goal is to provide educators with the information they need to make evidence-based decisions. We focus on the results from high-quality research to answer the question "What works in education?" Find more information about the WWC.



#### HIGHLIGHTS

#### **Charter Schools**

This new topic area focuses on the impact of charter schools on student academic achievement and other outcomes.







#### MISSION CRITICAL

Support credible science journalism. Subscribe to Science News today.



Search Science News...



**MENU** 

TOPICS

**BLOGS** 

EDITOR'S PICKS

MAGAZINE

LATEST

MOST VIEWED

NEWS

Zika could one day help combat deadly brain cancer

BY LAUREL HAMERS

SEPTEMBER 05, 2017

FEATURE

Learning takes brain acrobatics

BY LAURANDA (IDEA) SEPTEMBER 05, 201;

FEATURE

Teaching methods go from lab to classroom

DYCUSAN GAIDOS

SEPTEMBER 05, 2017

SCIENCETICKER

People may have lived in Brazil more than 20,000 years ago

BY BRUCE BOWE

SERTEMBER OF 201

SCIENCE TICKER

Spiritual convictions and group identities inspire terrorist acts, study finds

IN BRUCE BOWER

SEPTEMBER 04, 2017

MUCETYUPDATE

Innovative nonprofits receive \$20,000 in STEM Action Grants

REVIEWS & PREVIEWS

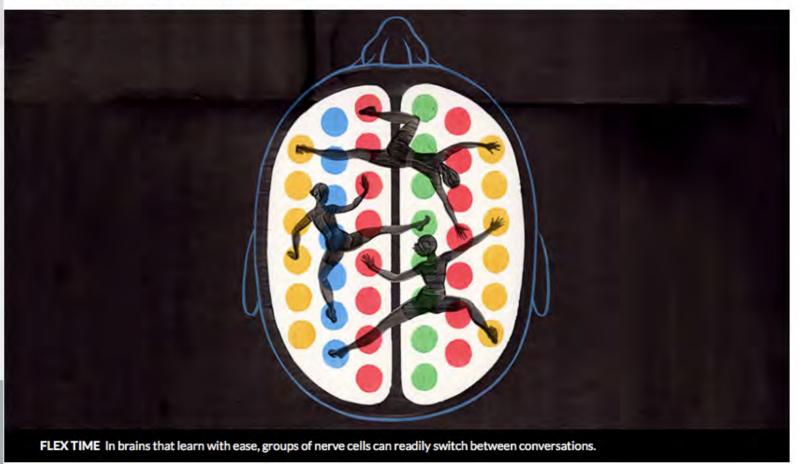
North America's largest recorded earthquake helped confirm plate

FEATURE NEUROSCIENCE

#### Learning takes brain acrobatics

When neural areas more easily switch communication partners, learning improves

BY LAURA SANDERS 11:00AM, SEPTEMBER 5, 2017



ALEX NABAUM

Peer inside the brain of someone learning. You might be lucky enough to spy a synapse pop into existence.



The Download

Magazine

**Events** 

More+

#### **Rewriting Life**

by the relevant muscles.

#### How Machine Learning Is Helping **Neuroscientists Crack Our Neural** Code

A big challenge in neuroscience is understanding how the brain encodes information. Neural networks are turning out to be great code crackers.

by Emerging Technology from the arXiv August 10, 2017







Whenever you move your hand or finger or eyeball, the brain sends a signal to the relevant muscles containing the information that makes this movement possible. This information is encoded in a special way that allows it to be transmitted through neurons and then actioned correctly

Exactly how this code works is something of a mystery. Neuroscientists

## What's the problem then?

#### The Seductive Allure of Neuroscience Explanations

#### Deena Skolnick Weisberg, Frank C. Keil, Joshua Goodstein, Elizabeth Rawson, and Jeremy R. Gray

#### **Abstract**

Explanations of psychological phenomena seem to generate more public interest when they contain neuroscientific information. Even irrelevant neuroscience information in an explanation of a psychological phenomenon may interfere with people's abilities to critically consider the underlying logic of this explanation. We tested this hypothesis by giving naïve adults, students in a neuroscience course, and neuroscience experts brief descriptions of psychological phenomena followed by one of four types of explanation, according to a 2 (good explanation vs. bad explanation) × 2 (without neuroscience

vs. with neuroscience) design. Crucially, the neuroscience information was irrelevant to the logic of the explanation, as confirmed by the expert subjects. Subjects in all three groups judged good explanations as more satisfying than bad ones. But subjects in the two nonexpert groups additionally judged that explanations with logically irrelevant neuroscience information were more satisfying than explanations without. The neuroscience information had a particularly striking effect on nonexperts' judgments of bad explanations, masking otherwise salient problems in these explanations.





Arts + Culture Business + Economy Education Environment + Energy Health + Medicine Politics + Society Science + Technology

#### So much talk about 'the brain' in education is meaningless

September 8, 2015 6.07am AEST



#### Authors



#### Jared Cooney Horvath PhD Student - Neuroscience,

Psychology, and Education at University of Melbourne



#### **Gregory Donoghue**

Learning Sciences Researcher & PhD Candidate at University of Melbourne

#### Disclosure statement

Jared Cooney Horvath works for the Science of Learning Research Centre (SLRC) at the University of Melbourne. The SLRC is funded through a Special Research Initiative of the Australian Research Council.

Gregory Donoghue is a student of, and works for, the Science of Learning Research Centre at the Melbourne University Graduate School of Education. The SoLRC is a Special Research Initiative of the Australian Research Council.

#### **Partners**

### **Education and the Brain: A Bridge Too Far**

JOHN T. BRUER

Educational Researcher, Vol. 26, No. 8, pp. 4-16

Brain science fascinates teachers and educators, just as it fascinates all of us. When I speak to teachers about applications of cognitive science in the classroom, there is always a question or two about the right brain versus the left brain and the educational promise of brain-based curricula. I answer that these ideas have been around for a decade, are often based on misconceptions and overgeneralizations of what we know about the brain, and have little to offer to educators (Chipman, 1986). Educational applications of brain science may come eventually, but as of now neuroscience has little to offer teachers in terms of informing classroom practice. There is, however, a

place, that indirectly link brain function with educational practice. There is a well-established bridge, now nearly 50 years old, between education and cognitive psychology. There is a second bridge, only around 10 years old, between cognitive psychology and neuroscience. This newer bridge is allowing us to see how mental functions map onto brain structures. When neuroscience does begin to provide useful insights for educators about instruction and educational practice, those insights will be the result of extensive traffic over this second bridge. Cognitive psychology provides the only firm ground we have to anchor these bridges. It is the only way to go if we eventually want to move between education and the brain.

The Neuroscience and Education Argument





Cognitive Science 26 (2002) 85–112

http://www.elsevier.com/locate/cogsci

### Spanning seven orders of magnitude: a challenge for cognitive modeling

John R. Anderson\*

Psychology Department, Carnegie Mellon University, Pittsburgh, PA 15213, USA
Received 1 May 2001; received in revised form 25 September 2001; accepted 10 November 2001

#### **Abstract**

Much of cognitive psychology focuses on effects measured in tens of milliseconds while significant educational outcomes take tens of hours to achieve. The task of bridging this gap is analyzed in terms of Newell's (1990) bands of cognition—the Biological, Cognitive, Rational, and Social Bands. The 10 millisecond effects reside in his Biological Band while the significant learning outcomes reside in his Social Band. The paper assesses three theses: The Decomposition Thesis claims that learning occurring at the Social Band can be reduced to learning occurring at lower bands. The Relevance Thesis claims that instructional outcomes at the Social Band can be improved by paying attention to cognition at the lower bands. The Modeling Thesis claims that cognitive modeling provides a basis for bridging between events on the small scale and desired outcomes on the large scale. The unit-task level, at the boundary of the Cognitive and Rational Bands, is useful for assessing these theses. There is good evidence for all three theses in efforts that bridge from the unit-task level to educational applications. While there is evidence for the Decomposition Thesis all the way down to the 10 millisecond level, more work needs to be done to establish the Relevance Thesis and particularly the Modeling Thesis at the lower levels. © 2002 Cognitive Science Society, Inc. All rights reserved.

Keywords: Cognitive modeling; Cognitive architectures; Education; Intelligent tutoring

Table 1 Newell's Time Scales of Human Action

Scale (sec)	Time Units	System	World (theory)
$\overline{10^7}$	months		
$10^{6}$	weeks		Social Band
$10^{5}$	days		
$10^{4}$	hours	Task	
$10^{3}$	10 min	Task	Rational Band
$10^{2}$	minutes	Task	
$10^{1}$	10 sec	Unit task	
$10^{0}$	1 sec	Operations	Cognitive Band
$10^{-1}$	100 msec	Deliberate act	
$10^{-2}$	10 msec	Neural circuit	
$10^{-3}$	1 msec	Neuron	Biological Band
$10^{-4}$	$100\mu s$	Organelle	

## What to do about it?



Contents lists available at ScienceDirect

#### Trends in Neuroscience and Education

iournal homepage: www.elsevier.com/locate/tine



#### The hard problem of 'educational neuroscience'

Kelsey Palghat<sup>a,d,\*</sup>, Jared C. Horvath<sup>b,d</sup>, Jason M. Lodge<sup>c,d</sup>

- a Queensland Brain Institute, University of Queensland, Australia
   b Melbourne Graduate School of Education, University of Melbourne,
   c Melbourne Centre for the Study of Higher Education, University of I
- d ARC-SRI Science of Learning Research Centre, Australia

#### ARTICLE INFO

Philosophy Science of learning ABSTI Differing wo

to productiv epistemolog plinary fields issues of ph such, a lack masquerade mind (speci educational beliefs, and researcher i philosophica



HIGHER EDUCATION RESEARCH & DEVELOPMENT, 2016 VOL. 35, NO. 3, 634-637 http://dx.doi.org/10.1080/07294360.2015.1094204



POINTS FOR DEBATE

#### Do the learning sciences have a place in higher education research?

Jason M. Lodge 🗓

Melbourne Centre for the Study of Higher Education Melbourne, Melbourne, VIC, Australia

Higher education, as a research discipline models, frameworks and approaches to u the digital age are inadequate (Laurillar higher education have with information way that students access and use knowled; sities and higher education researchers are change (Bates & Sangra, 2011). This w policy is perhaps best exemplified in th massive open online courses (MOOCs).

Special Issue Article

#### Understanding and addressing mathematics anxiety using perspectives from education, psychology and neuroscience

ARC-SRI: Science of Learning Research Centre, Australia

ARC-SRI: Science of Learning Research Centre, Australia

#### Merrilyn Goos

Head, School of Education, The University of Queensland, ARC-SRI: Science of Learning Research Centre, Australia

Curtin University, Australia; ARC-SRI: Science of Learning F Centre, Australia

#### Sue Thomson

Educational Research, Australia; ARC-SRI: Science of Learnin Centre, Australia

#### Abstract

that state or on-task mathematics anxiety impacts anxiety leads to the avoidance of courses and c rate that integrating perspectives from a

Research Fellow, Australian Council for Educational Research

Research Fellow, Australian Council for Educational Research

Ottmar V Lipp

Director, Educational Monitoring and Research, Australian (

Mathematics anxiety is a significant barrier to mathem

#### Sarah Buckley

Professor of Psychology, School of Psychology and Speech F

#### OPEN ACCESS

George Washington University, USA

Reviewed by: University of Nevada, Las Vegas, USA The University of Alabama, USA

Australian Council for Educational Resean Australian Journal of Education 2016, Vol. 60(2) 157-170

© Australian Council for Educational Research 2016 Reprints and permissions: DOI: 10.1177/0004944116653000

> aed.sagepub.com **\$**SAGE





#### A Bridge Too Far – Revisited: **Reframing Bruer's Neuroeducation Argument for Modern Science of Learning Practitioners**

Jared C. Horvath\* and Gregory M. Donoghue

In Education and the Brain: A Bridge neuroscientific findings must filter the to the classroom, with increased k someday be built. Here, we suggest process: rather, we demonstrate th be built between these two fields. I a matter of information lack, a pn most relevant to Bruer's argument to incommensurability between no limitation inherent in all sciences. Aft apply this concept to the learning sc be behaviorally translated before pre We conclude by exploring example and adopting a levels-of-organizat beneficially guide research and prac

npj | Science of Learning

EDITORIAL OPEN

#### Integrating neuroscience and learning: now's the time...

npj Science of Learning (2016) 1, 16007; doi:10.1038/ npjscilearn.2016.7; published online 11 May 2016

The ability to learn and to retrieve information from memory arose early in the evolution of animals, and is present across all species, from humans to the simple roundworm (C. elegans). The capacity to learn is critical for survival, whether it be to find food and avoid predators, or to engage in effective social interactions and be productive in the workplace. Our ability to increase human exercise its linear because the survival and the contractions and be productive in the workplace. Our ability to increase human potential is linked to our ability to learn at all life stages. Using experimental models, in recent decades, the fields of neuro and experimental psychology have made great strides in under-standing how learning occurs, both in terms of cognitive processes, and their underlying neural mechanisms. These studies are providing insight into questions about learning, and possible are providing insight into questions about learning, and possible translational solutions from the cradle to the classroom. For example, this work is beginning to provide an understanding of disorders in memory formation, storage and retrieval, such as with ageing and dementia<sup>1</sup>, it is also exploring stress, sleep and fear as factors that diminish learning.

While it is widely believed that the same mechanisms and

systems underpin learning at large—in the classroom and in informal learning environments—minimal progress has been made to advance the translation and practice of this information. In other words, the results of experimental studies are incon-

contribute to understanding learning. We aim to publish cutting edge research on the mechanisms that underpin and influence learning and memory formation in experimental systems, as well as the pedagogical and social factors that influence education. The open-access nature of this journal facilitates the support of scientists, educators, informal learning advocates and policy makers to drive experimental investigations, and guide the practice and assessment of education. We aim to yould the practice and assessment of education. We aim to publish findings in the functional, cellular, molecular, cognitive and systems studies of learning and memory formation, as well as the ideas and thinking of education theory, it is the link that matters for npj Science of Learning. To support cross-talk between disciplines, a lay summary will accompany each research article, to make the findings more accessible to both scientists, formal educators, advocates, informal educators and policy

This diversity is refected in the scope of articles in this first issue. Long-term potentiation (or LTP) is a form of synaptic plasticity that is believed to be the cellular basis for memory storage. As with memory formation and consolidation, LTP has early short and late persistent phases, and different molecular mechanisms mediate persistent priases, and dimerent molecular interchalisms mediate the short and persistent forms of LTP, Pang et al.<sup>2</sup> show that just as with the early phase of LTP, the persistent form also has two phases: induction and mainteniance. They show the two forms require differential cleavage of the protein brian-derived neuroEdited by Jared Cooney Horvath, Jason M. Lodge, and John Hattie









## LABORATORY TO THE CLASSROOM







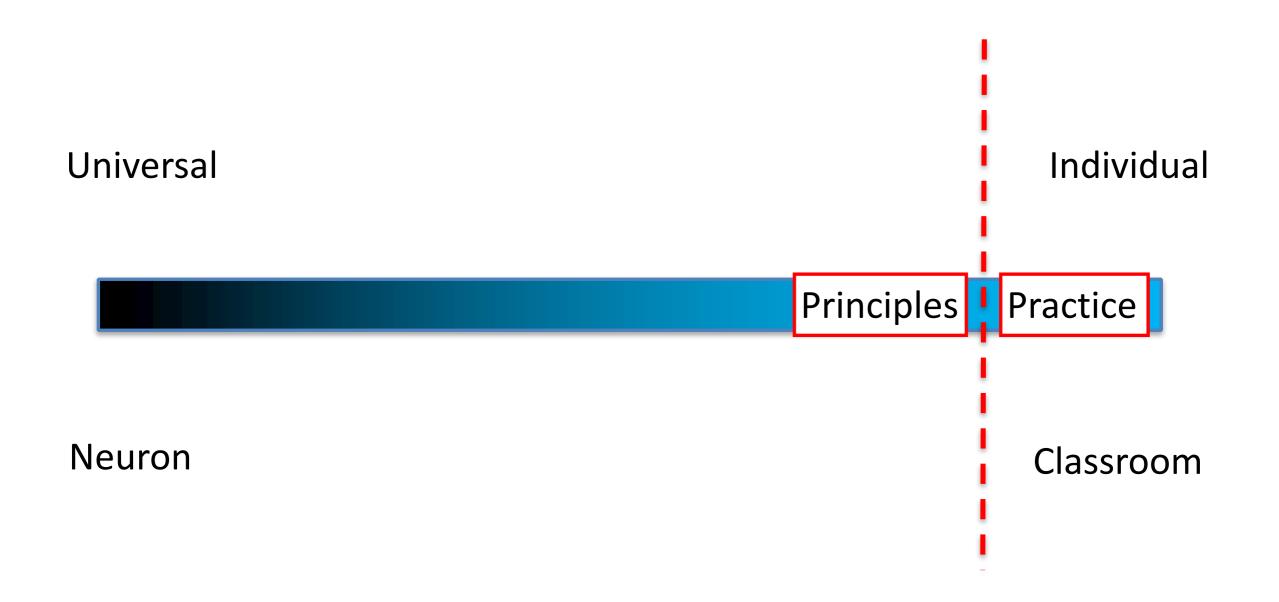
TRANSLATING SCIENCE OF LEARNING FOR TEACHERS

Diagnostic

Functional

Conceptual

Prescriptive



### HOW LEARNING WORKS

Research-Based Principles for Smart Teaching

Susan A. Ambrose
Michael W. Bridges | Michael DiPietro
Marsha C. Lovett | Marie K. Norman

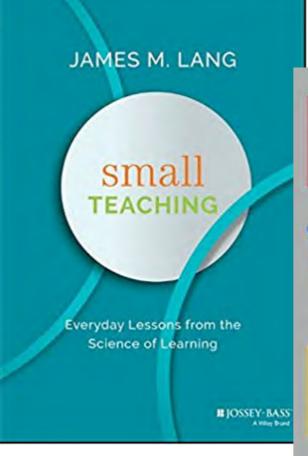
FOREWORD BY RICHARD E. MAYER

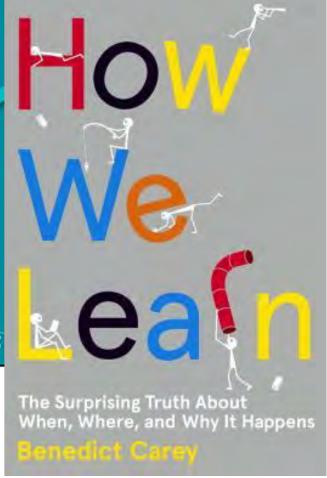
make it stick



The Science of Successful Learning

Peter C. Brown Henry L. Roediger III Mark A. McDaniel







## Improving Students' Learning With Effective Learning Techniques: Promising Directions From Cognitive and Educational Psychology

Psychological Science in the Public Interest 14(1) 4–58
© The Author(s) 2013
Reprints and permission:
sagepub.com/journalsPermissions.nav
DOI: 10.1177/1529100612453266
http://pspi.sagepub.com



John Dunlosky<sup>1</sup>, Katherine A. Rawson<sup>1</sup>, Elizabeth J. Marsh<sup>2</sup>, Mitchell J. Nathan<sup>3</sup>, and Daniel T. Willingham<sup>4</sup>

<sup>1</sup>Department of Psychology, Kent State University; <sup>2</sup>Department of Psychology and Neuroscience, Duke University; <sup>3</sup>Department of Educational Psychology, Department of Curriculum & Instruction, and Department of Psychology, University of Wisconsin–Madison; and <sup>4</sup>Department of Psychology, University of Virginia

#### **Summary**

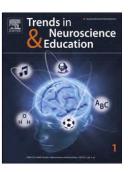
Many students are being left behind by an educational system that some people believe is in crisis. Improving educational outcomes will require efforts on many fronts, but a central premise of this monograph is that one part of a solution involves helping students to better regulate their learning through the use of effective learning techniques. Fortunately, cognitive and educational psychologists have been developing and evaluating easy-to-use learning techniques that could help students achieve their learning goals. In this monograph, we discuss 10 learning techniques in detail and offer recommendations about their relative utility. We selected techniques that were expected to be relatively easy to use and hence could be adopted by many students. Also, some techniques (e.g., highlighting and rereading) were selected because students report relying heavily on them, which makes it especially important to examine how well they work. The techniques include elaborative interrogation, self-explanation, summarization, highlighting (or underlining), the keyword mnemonic, imagery use for text learning, rereading, practice testing, distributed practice, and interleaved practice.



Contents lists available at ScienceDirect

#### Trends in Neuroscience and Education





#### The hard problem of 'educational neuroscience'



- <sup>a</sup> Queensland Brain Institute, University of Queensland, Australia
- <sup>b</sup> Melbourne Graduate School of Education, University of Melbourne, Australia
- <sup>c</sup> Melbourne Centre for the Study of Higher Education, University of Melbourne, Australia
- <sup>d</sup> ARC-SRI Science of Learning Research Centre, Australia

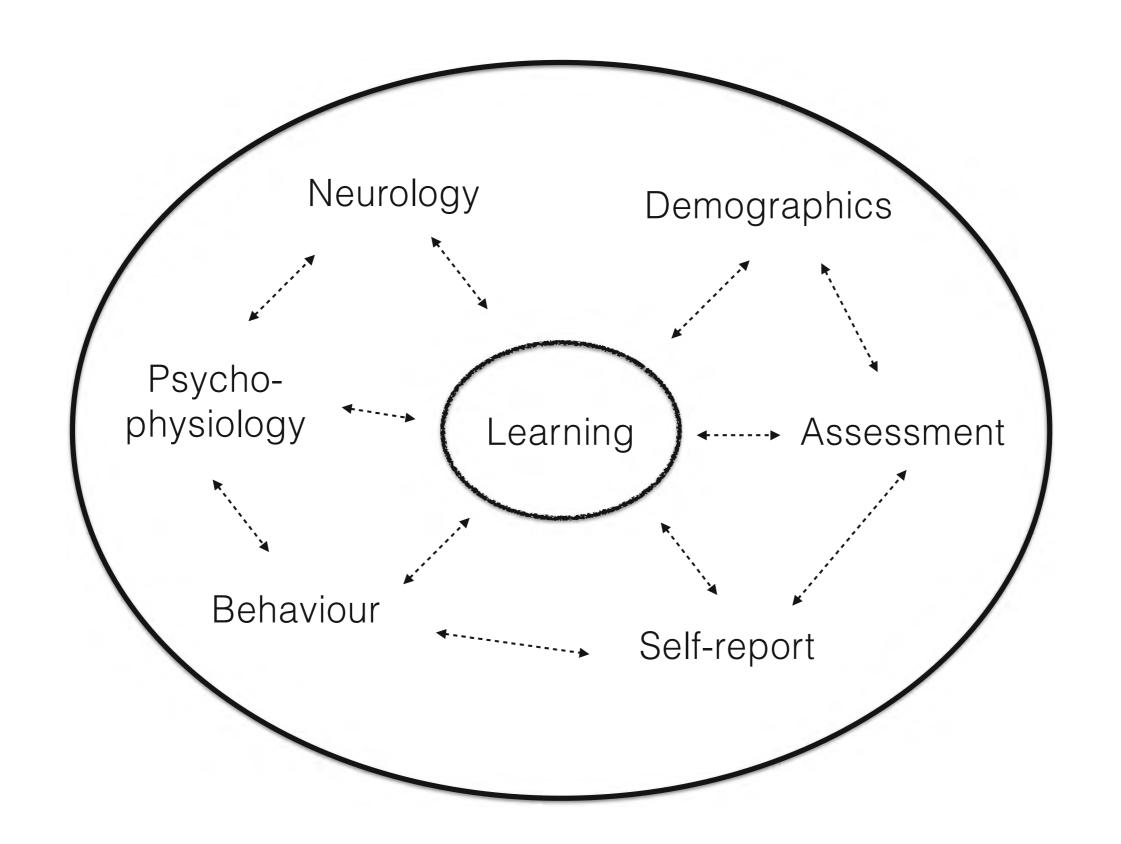


#### ARTICLE INFO

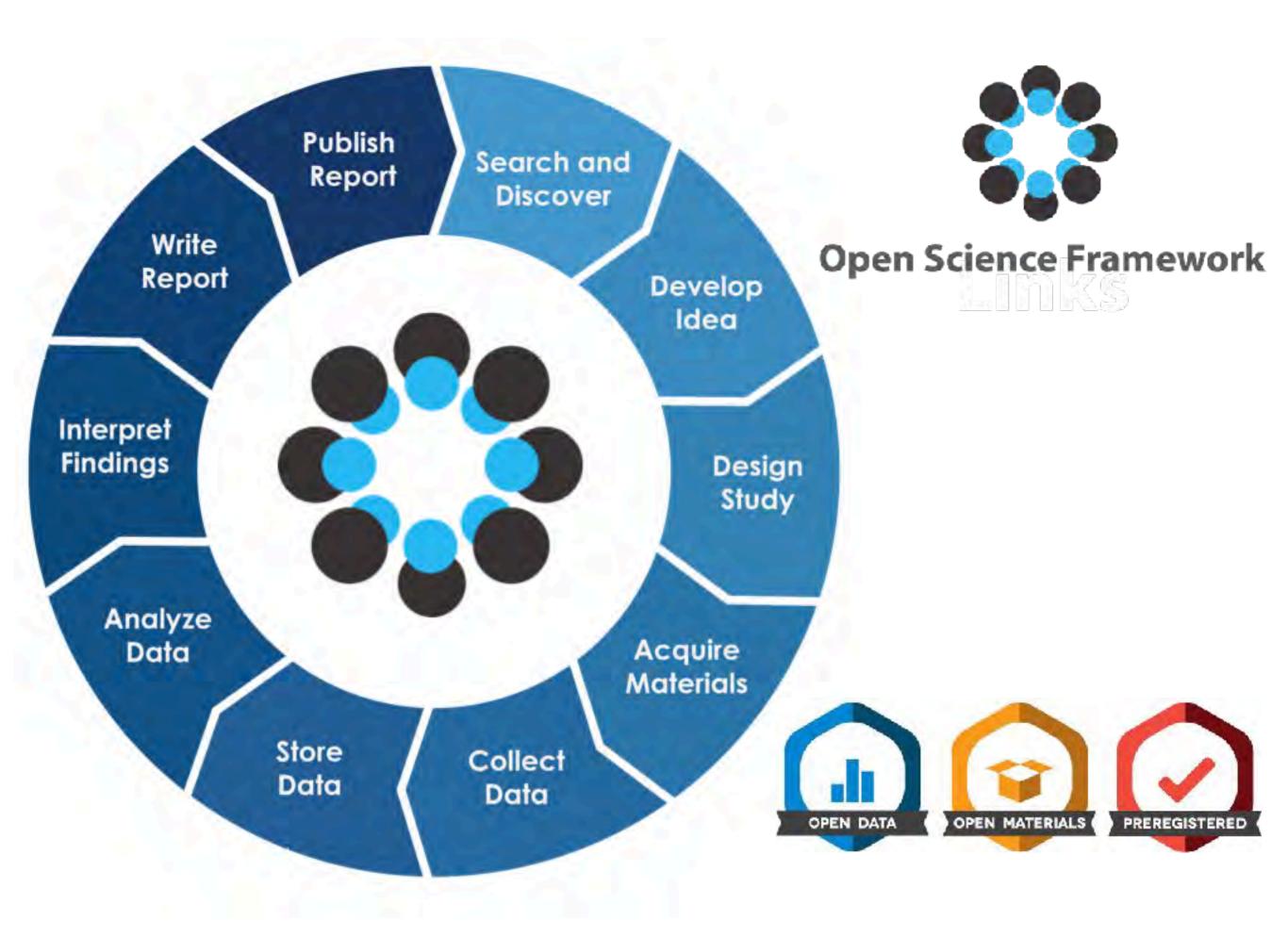
Keywords: Interdisciplinary Philosophy Science of learning Mind-body Translation

#### ABSTRACT

Differing worldviews give interdisciplinary work value. However, these same differences are the primary hurdle to productive communication between disciplines. Here, we argue that philosophical issues of metaphysics and epistemology subserve many of the differences in language, methods and motivation that plague interdisciplinary fields like educational neuroscience. Researchers attempting interdisciplinary work may be unaware that issues of philosophy are intimately tied to the way research is performed and evaluated in different fields. As such, a lack of explicit discussion about these assumptions leads to many conflicts in interdisciplinary work that masquerade as more superficial issues. To illustrate, we investigate how philosophical assumptions about the mind (specifically the hard problem of consciousness and mind-body problem) may influence researchers in educational neuroscience. The methods employed by researchers in this field are shaped by their metaphysical beliefs, and arguments around these issues can threaten accepted disciplinary ontologies. Additionally, how a researcher understands reduction in the special sciences and how they place their colleagues in this ontology constrains the scope of interdisciplinary projects. In encouraging researchers to explicitly discuss the philosophical assumptions underlying their research we hope to alleviate some of the conflict and establish realistic expectations for collaborative projects.



Lodge, Alhadad, Lewis & Gašević, 2017



# HANDBOOK OF Implementation Science for Psychology in Education

BARBARA KELLY
DANIEL F. PERKINS

