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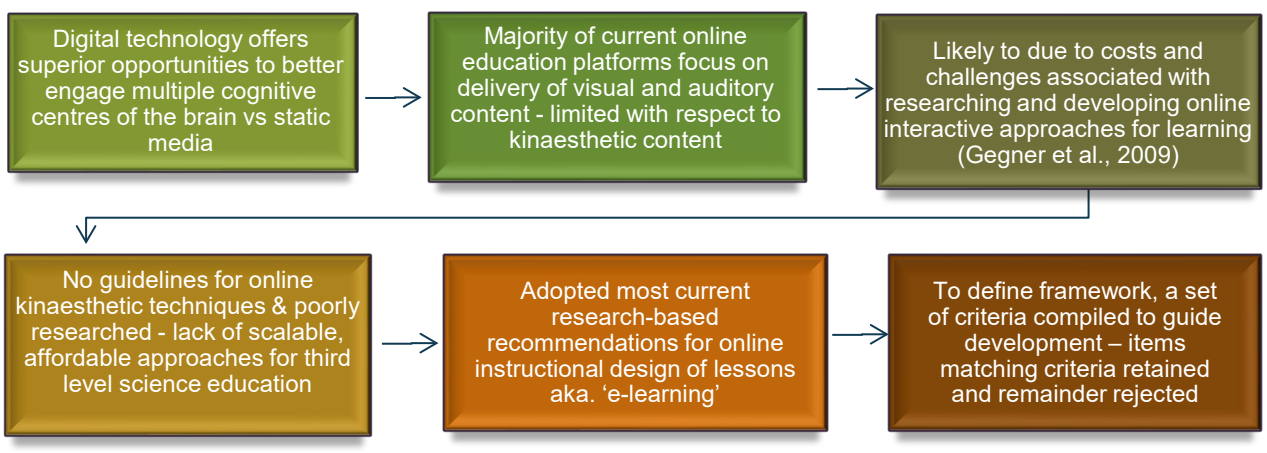
Development and Evaluation of Online Approaches for Improved Kinaesthetic Learning in Science

Anna Scanlan

The Proposed Topic of Research

The science of learning is concerned with how the best learning can be achieved through research of instruction and assessment methods (Clark and Mayer, 2008; Mayer, 2018). In terms of the evolution of learning, we have entered a new era in which digital technologies provide a powerful means of delivering education content on a scale previously impossible and unforeseen, enabling near global access. This is particularly evident when the interactive nature, rapid manipulation of content and sharing capacity of digital technology is considered. Yet research on the development and employment of such technologies for education has lagged significantly behind their widespread social adoption (CSO, 2018; OECD, 2018). While great strides have been made in the development of online learning platforms, there remains huge scope for systematic improvement and optimisation, through well founded research approaches. These in turn should be developed based on sound theory and rigorous methodological studies (Clark and Mayer, 2008; Sankey *et al*., 2011). My thesis work tackles one of the great, unaddressed challenges remaining in online or electric learning, referred to as 'e-learning,' that is, to provide research into how physical, tactile or 'kinaesthetic' learning might be successfully integrated into online platforms for learning, and in particular for learning difficult, abstract concepts in science.

Nature and Scope of Research



Current Research in Science and Online Learning

The 'Anatomage Table' is an excellent and successful example of discipline specific online kinaesthetic learning for anatomy. However, developing online kinaesthetic techniques for use in learning anatomy, are likely to be significantly less challenging than developing such techniques for use in learning molecular science. Anatomy students will already be familiar with anatomical and medical concepts and terminology. By contrast, molecular biology is awash with unfamiliar and abstract concepts and requires learning of an extensive new science vocabulary. Compare the Anatomage Table on the right with the image of various proteins and the schematics for the gene regulation system in Lambda bacteriophage. Now, imagine seeing each for the first time. It becomes quickly apparent that conceptually, science disciplines such as anatomy, are intuitively easier to grasp than molecular science. Education and science literature contains many acknowledgements of the lack of research for online kinaesthetic learning and there are calls to increase the scope of research for online learning to STEM subjects of a complex nature (Gegner *et al*., 2009; Sankey *et al*., 2011).

Objectives

The main objectives are to identify, design and investigate novel approaches and tools for facilitating kinaesthetic learning of educational content online. The immediate aim is to develop a variety of online lessons requiring a kinaesthetic approach to participate referred to as a '*kinaesthetic learning system*' (KLS). The long-term goal is to develop a suite of learning tools and build them into a framework of online KLS approaches. I hypothesise that KLS will significantly enhance learning especially for grasping new concepts, for understanding advanced science methodologies and for enhancing knowledge retention. Key parameters governing research design: approaches and tools developed must be scalable, affordable and amenable to widespread sharing and adoption for use by other educators. As software, hardware and cloud computing systems continue to develop, the prospect of developing online education material that further enables and enhances the application of KLS is increasingly feasible, particularly for complex theoretical subjects in the sciences. Online KLS lessons that prove successful will be screened from the unsuccessful, with results and feedback facilitating prototype development

Defining the Framework

A methodical effort was applied toward developing new kinaesthetic approaches that would transfer well to an online platform. The following are some of the key parameters:

- Simple design that lends itself to reproduction in accessible formats e.g. Microsoft Office
- Affordable, expandable and scalable, user friendly and lead to intuitive understanding
- All items must be amenable to the application of scientific research methodology i.e. design, build, test, repeat

Assessment and Evaluation

The key aspect of assessment and evaluation will focus on determining if students have developed understanding, short-term learning, long-term recall, more attentive behaviour to online lessons with less tendency toward distraction:

- Recruiting ~200 1st year undergraduate students with no exposure to key topic
- Comparison of a kinaesthetic test group vs. non-kinaesthetic control group, with identical online lesson – 1 variable: kinaesthetic interaction
- Assessment via MCQ and transfer testing
- Formative evaluation
- Simple model will be incorporated into a more complex model
- Test KLS in realistic setting – students own devices
- Return to subject matter at a later date – two time points

Impact

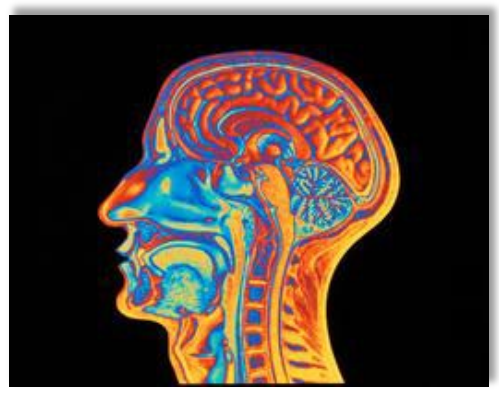
We are anticipating a scalable, expandable, affordable and adaptable framework of KLS

Regardless of outcome, study is addressing lack of research and laying groundwork for further research

Concept Table is a novel, emergent idea – a standard reference for rating lesson complexity in the sciences

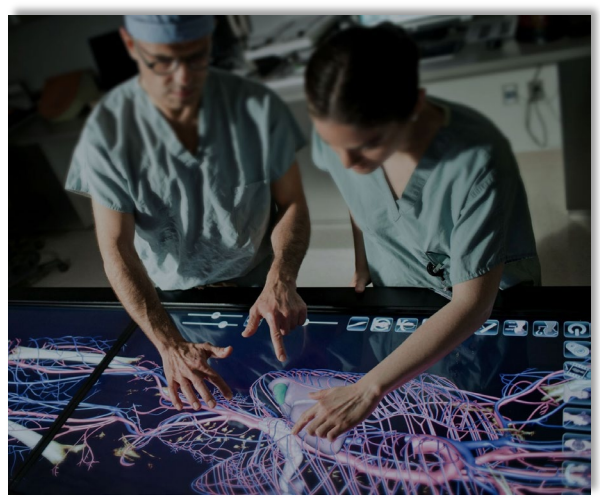
Apply idea of the Concept Table to science illustrations

Potential for transfer to all levels of education

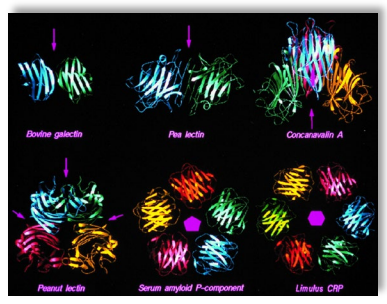


Brain image sourced from: **Why some memories stick: Repetitive neural responses may enhance recall of faces and words.** Janelle Weaver Published online 9 September 2010 | Nature | doi:10.1038/news.2010.457

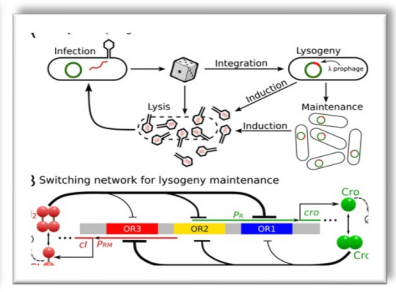
Kinaesthetic learning is expressed when physical actions are used to connect concept development to reality, such as through model building, trial and error practice or role-play interactions
(Slater *et. al.,* 2007; Bolliger and Supanakorn, 2011; Fleming, 2018)



Anatomage Table (URL 1)



Symmetry, stability, and dynamics of multidomain and multicomponent protein systems Tom L. Blundell and N. Srinivasan PNAS December 10, 1996 93 (25) 14243-14248



Lambda Phage (URL 3)

Progress to Date

The first approach to be tested will be KLS 1 'Assembly' using Lac Operon lesson
Approaches applied to a variety of 3rd level science lessons - will be rejected, reconfigured or progress forward for testing with other science topics

KLS 1	Assembly
KLS 2	1st Person Perspective
KLS 3	Personal Choice Interaction
KLS 4	Story boarding
KLS 5	Trial and Error
KLS 6	Personal Pacing
KLS 7	Diagram Formats

Science Topic – The Lac Operon

The Lac Operon is a regulation system for metabolism of lactose in *Escherichia coli* (E. coli). It is a paradigm for positive and negative gene regulation and is exceptionally well understood at the molecular level. It is also a key topic globally in the curricula of molecular sciences and poses a conceptually difficult 3rd level science lesson. The complexity of lesson a strong challenge to our hypothesis and we spent ~ 2 months studying concepts & language to adapt for KLS testing - ensures language not a confounding factor and minimises variables. Through this process, we developed a 'Concept Table' which identifies the number of concepts in the lesson and can be used as a measure to rate lesson complexity.

Lac Operon Lesson 1 Concept Table

Concept Total 40:	Lac Operon Lesson 1
4	DNA in all living things : inherited : instructs : proteins
2	Cell functions : amino acids make proteins
New Language Total: 24	
2	DNA, proteins
Descriptive Analogy Tot: 8	
1	DNA instruction manual
2	Proteins as worker molecules : amino acid building blocks
Information Total: 11	
1	Bacterial division
3	Role of proteins : abundance : size range

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URL 1: https://www.anatomage.com/image-library/
(URL 2) https://doi.org/10.1073/pnas.93.25.14243
URL 3: https://biotechkhan.wordpress.com/2014/07/14/lambda-phage/

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