

Catalysing interdisciplinary and integrative thinking through the scholarship of teaching and learning



Kathy Takayama

Associate Director for Life & Physical Sciences
The Harriet W Sheridan Center for Teaching & Learning
Adjunct Associate Professor
Department of Molecular Biology
Cell Biology & Biochemistry
Brown University, USA
Visiting Fellow, The University of New South Wales, School of Biotechnology and Biomolecular Sciences, NSW
Email Kathy_Takayama@brown.edu

There is a likeness between the creative acts of the mind in art and in science – Jacob Bronowski¹

Science by its very nature is interdisciplinary and scientific research relies on the collaborative skills and expertise of researchers across the disciplines. Yet, science as taught in the university classroom is usually compartmentalised into separate subjects. Most undergraduate students are not exposed to the excitement and challenge of connecting the concepts, skills and processes learnt within these distinct disciplines until they enter the laboratory as an honours student. Indeed, opportunities for problem-solving, novel application of concepts, articulation of the broader impacts and societal benefits of scientific research and understanding are not usually explicitly designed and scaffolded as an integral part of the university syllabus, but these lifelong skills are essential for scientific thinking². Furthermore, one of the most crucial elements that nurtures scientists' engagement and creativity is seldom considered an essential component of the curriculum – the interaction with local, national and international peer communities to share, to receive feedback and to foster new ideas and collaborations. Considered from a holistic perspective, many academics tend to focus on content, while the process of scientific inquiry is peripheral to the formal syllabus. The scholarship of teaching and learning brings the focus back to inquiry thinking and learning, by prompting academics to critically engage with the pedagogical process.

The scholarship of teaching and learning (SoTL) enables academics and their respective disciplines to consider a more integrative approach to student learning. In 1990, Ernest Boyer's seminal report *Scholarship Reconsidered: Priorities of the Professoriate* (the Boyer Report)³ called upon universities to rethink what scholarship means. Four types of academic scholarship were outlined by Boyer:

- Scholarship of **discovery**, referring to the disciplinary research academics engage in and publish.
- Scholarship of **integration**, referring to the intellectual work and writings allowing us to construct, see and understand the connectedness of all things.
- Scholarship of **application**, referring to the application of knowledge to real world problems for the betterment of worlds big and small.
- Scholarship of **teaching**, referring to the works of helping others understand and construct knowledge so they may engage in the other forms of scholarship.

The first three scholarships are easily understood and practised by science academics. As defined by Boyer, the scholarship of teaching (now extended to include learning) connects and encompasses all other forms of scholarship and facilitates their perpetuation. Academics have years of formal and informal apprenticeship and mentoring in their discipline. They possess the fundamental knowledge to conduct evidence-based research: they know how to review and query the literature; define answerable problems; design appropriate measures; collect and analyse data; and publish their findings in scholarly journals. What has been missing is the transfer or application of these same research skills from their discipline to their teaching. When science academics engage their teaching with the same toolsets and rigour that they routinely use in their disciplinary research, the results are transformative for the academic, the students learning in their classes and the curriculum. Applying the scholarship of discovery to one's teaching should be a natural process for scientists. It is when teaching and research are siloed into separated compartments that researchers fail to apply their research scholarship skills to teaching.

In essence, the scholarship of teaching and learning catalyses the

integration of research and teaching. Moreover, it fosters cross-disciplinary approaches to teaching that engage students with different backgrounds, interests and learning styles. Integrative learning creates opportunities for students to make connections across experiences, studies and knowledge. These connections help them to problem-solve and meet the needs and challenges of our complex world and society⁴. How do we apply scholarship in our teaching to create integrative learning opportunities?

Integrative learning develops when teaching is considered through an integrative framework⁵. One might consider a challenging problem in teaching and look to successful models from other disciplines to understand how a process works. Take the previous challenge described above, that of the lack of engagement in authentic science inquiry communities in undergraduate courses. Such communities interact collaboratively and develop the disciplinary habits of mind that real scientists utilise. In order for students to actively become part of a community of inquiry, they need to develop inquiry thinking. What makes it challenging to teach inquiry thinking? Common responses from science academics include the following:

- Concept of learning through inquiry versus spoon-feeding.
- Engaging in the *process* of learning instead of someone handing them the material.
- Connecting inquiry in principles to inquiry in reality (theory versus application or real life).
- Making abstract concepts or hypothetical situations 'real'.
- Helping students recognise that they need to ask questions at certain key points.
- Teaching students how to ask relevant, informed questions.
- Teaching students how collaborative dialogue leads to new questions and further inquiry.

Each of these points can serve as a starting point for further investigation by academics into their students' learning. On the other hand, one could look for a broader framework by which all of these requisite attributes can be integrated into a strategy for scaffolding student learning. Such was the case when the focus on collaborative inquiry was shifted from science to examining successful models in the creative arts. The process of design thinking and making involves similar processes of critical analysis, questioning, testing, collaborative discussion and further new exploration. The merging of visual arts with the sciences has been successful in bringing together groups of students from different scientific disciplines to collaboratively investigate authentic problems that they defined, using strategies that they developed through the integration of their respective

expertise and experiences^{6,7}. For the instructor, the approach leads to a 'hybrid pedagogy' – a hybrid of the cognitive and sensory frameworks and processes that define the respective original pedagogies (for example visuality of the creative arts + inquiry in the sciences; threaded together through collaborative engagement). Hybrid pedagogies are transformative because they provide new insight into the disciplines and they create opportunities for more inclusive teaching. I define hybrid pedagogies as sharing the following characteristics⁸:

- They lead to the empowerment of ideas⁹.
- They lead to the empowerment of voices.
- They are 'dendritic' – that is, like the cells of the neural network, they branch out, they are receptive to a range of incoming signals and they function to amplify signals.
- They are 'symbiotic' – the interdependence of the original pedagogies that form the hybrid pedagogy facilitates cognitive blending and risk-taking.

The scholarship of teaching and learning can illuminate other ways to integrate disciplines and enable us to create more successful approaches to curriculum development for the coming generation of students, who represent a diverse learning population.

References

1. Bronowski, J. (1956, 1965) *Science and Human Values*. Julian Messner Inc, New York.
2. Chinn, C.A. & Malhotra, B.A. (2002) Epistemologically authentic inquiry in schools: A theoretical framework for evaluating inquiry tasks. *Sci. Educ.* 86, 175-218.
3. Boyer, E.L. (1990) *Scholarship Reconsidered: Priorities of the Professoriate*. Jossey-Bass.
4. Huber, M.T. & Hutchings, P. (2004) *Integrative learning: Mapping the terrain*. Association of American Colleges and Universities.
5. Huber, M.T. *et al.* (2005) Integrative learning for liberal education. *Peer Rev.* Summer/Fall 4-7.
6. Takayama, K. (2003) Visualising the Science of Genomics – an international online research project. *Microbiol. Aust.* 24, 32-33.
7. Takayama, K. (2005) Teaching visualizing the science of genomics. In *Visualization in Science Education* (Gilbert, J.K. ed.), 217-251, Springer.
8. Takayama, K. (2009) Communities, Voices and Portals of Engagement. *International Journal for the Scholarship of Teaching and Learning*. At: http://academics.georgiasouthern.edu/ijsotl/v3n2/essays_about_sotl/_Takayama/index.htm
9. Papert, S. (2000) What's the big idea? Toward a pedagogy of idea power. *IBM Syst. J* 39, 720-729.

Biography

Kathy Takayama's interests are in: i) the regulation of RNA processing mechanisms; ii) visualisations in science education; iii) the integration of art and science; iv) online learning communities; and v) the Scholarship of Teaching and Learning (SoTL). From 1994 to 2007 she was an academic in the School of Biotechnology & Biomolecular Sciences at the University of New South Wales in Sydney, Australia. She is currently the Associate Director for Life & Physical Sciences at the Sheridan Center for Teaching and Learning, and Adjunct Associate Professor in the Department of Molecular Biology, Cell Biology and Biochemistry at Brown University. Kathy is a Carnegie Scholar and a founding member of the International Society for the Scholarship of Teaching and Learning. She is also a recipient of the 2005 ASM David White Award for Excellence in Teaching.