OPINION PIECE

Different Perspective, Same Challenges

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Abstract

I present a perspective on one of the most important challenges facing teaching and learning, in the Physical Sciences and many other disciplines. I argue that the challenge is less about finding novel ways to enhance student learning but ensuring a wider and more rapid take up of evidence-based approaches that have been convincingly shown through research studies to be effective in creating conditions for successful learning. I offer some advice to those engaged in supporting teaching and learning, from academic staff at the coalface, to institutional leaders and the HEA.

Keywords: teaching and learning, innovation, culture change, leadership

Following my recent move to UBC in Vancouver, I can now lay claim to having taught physics and chemistry students on three continents. (I am claiming Africa – somewhat tenuously – on the basis of a single revision lecture in thermal physics whilst on a visit in 2011 to the University of KwaZulu-Natal). I've recently completed a semester of teaching on one of the first year physics courses for non-majors at UBC, delivered to over 1,500 students each year. That experience, coupled with my role as Senior Advisor for Teaching and Learning (which I interpret liberally as the right to stick my nose into pretty much anything to do with teaching and learning on campus) has given me an interesting perspective from which to compare and contrast my time in the UK. Different contexts, without a doubt, but many of exactly the same challenges.

Earlier in my career, when some of my former colleagues might say I was still doing *proper* physics research, I used to write applications to use national supercomputing facilities to solve 'Grand Challenge' problems. Recently, I have been reflecting on the applicability of the same phrase to issues in

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undergraduate education. I've come to think of the Grand Challenge in this context as the need, desire and imperative to alter curricula and the way they are taught to focus more explicitly on enhancement of skills, abilities and attitudes, and less on content and its acquisition. The goal of such a challenge is simple: to improve the effectiveness of the learning experience and to equip graduates with the requisite skills to tackle major challenges that will face them in their lifetime (that's a whole other set of grand challenges…).

This may all sound very familiar to you. Perhaps you've heard colleagues at your own institution express similar views, or read words like this in strategic documents or as mission statements? Articulating the challenge is, however, only the start of the story. The practical problem that needs to be addressed in order to be able to make serious progress towards achieving these goals is not what you might think. I believe it is no longer about discovery of the innovative practices in teaching and learning that will be effective to foster higher order thinking skills, develop problem solving capabilities, refine skills for collaboration, nurture critical thinking, and so on. Extensive research, particularly in the last two decades, synthesising studies across cognitive science, psychology, education, brain research and other disciplines has taught us a huge amount about how learning works (Ambrose *et al.* 2010). Furthermore, these principles have been corroborated by numerous classroom studies or field trials indicating effectiveness of particular interventions. The problem, simply stated, is to expand the range and rate of uptake of those instructional practices that have been conclusively shown to improve student learning. In short, it's about taking enough of your colleagues with you, so that you irreversibly shift the ethos about teaching and learning in a department or institution: it's about culture change.

The traditional model of the spread of innovation in teaching and learning within a department has, to a first approximation, been one of 'indirect contagion'. When people use innovative approaches and pedagogies in their classes and with their students, these will simply rub off on others and diffusion of innovation will naturally follow. The problem is that the diffusion constant for this process is extremely slow, verging on glacial: it simply doesn't happen fast enough (if at all). At UBC, a 'stimulated contagion' strategy has been deployed on a large scale. We are now approaching the end of a time-limited experiment to see if it is possible to permanently alter the culture and attitude towards teaching and learning across an entire faculty group. The Carl Wieman Science Education Initiative began in earnest in 2007 (see http://www.cwsei.ubc.ca – accessed 23rd April 2013), with the explicit aims of agreeing within a department what it is that students *should* be learning; to devise ways to *measure* that learning; and to deliver and evaluate interventions designed to *improve* student learning. The initiative was implemented with injection of significant resources (principally human, in the form of Science Teaching and Learning Fellows or STLFs) across all nine departments in the Faculty of Science. It's very much an experiment still-in-progress, as the real measure of its effectiveness will be judged some time after the funding injection has passed, to see if the transformations (of courses, of faculty members and of departments) really are irreversible.

There has certainly been differential progress in the nine departments, not least because they each started the process with a unique set of initial conditions. However, there have also been notable and significant successes: compelling evidence for the effectiveness of research-based instructional strategies, even when deployed by novice teachers (Deslauriers *et al.* 2011); development of multiple concept inventories to measure learning; two-stage examinations that essentially solve the problem of how to deliver timely feedback on exam performance to students to name just a few. Recent research from physics faculty in the US has shown that the majority have been exposed to and indeed used at least one such research-based instructional strategy, but that approximately one-third subsequently stop using it (Henderson *et al.* 2012). Equivalent data collected for a comparable population at UBC – faculty who have had at least a year since direct STLF support has been withdrawn – suggest the proportion dropping these strategies is far less (only 1 member of staff out of 70 in the test group).

However, few institutions will have several million dollars of spare cash available and a Nobel Laureate to lead the charge towards systematic and purposeful transformation in this manner. Nonetheless, there are things that could and should be done to make some progress towards the overall goal of change. Having outlined what I think the main challenge is facing teaching and learning, it seems only appropriate for me also to try and offer pointers towards solutions, though there are no magic bullets to be found here.

I will finish by highlighting what I hope will be practical advice for …. well, everyone with a stake in the delivery of teaching and learning. I imagine that the largest readership of this piece will be teaching and learning practitioners in the physical sciences. My advice to you would be to be active in fostering collaborations, both with those within and outside your institution. Within your own department, if you are interested in tackling the problem head-on and busting departmental myths

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about teaching and learning in your discipline, designing the 'killer' experiment or intervention is a high-gain (but also potentially high risk!) strategy. Within your institution, you may find people with similar interests to be found, perhaps via teaching and learning centres, professional development events or through groups or individuals actively engaged in discipline-based pedagogical research. In the journal club sessions I used to organise for the Physics Education Research group at Edinburgh, we frequently included vets, mathematicians, engineers, biologists and chemists, and our discussions were all the richer for it.

I would urge those of you who are directors of teaching or department heads to creatively reorganise and restructure the classrooms of your discipline. Deliberate perturbation of the structural status quo, moving away from the canonical model of one-instructor per course, can generate productive disequilibrium. Example strategies in the form of peer- and/or team teaching, using senior undergraduates as 'community' teaching assistants and involving students as co-producers of learning materials have all been demonstrably effective in science contexts, and need not be prohibitively expensive to resource.

To those with institutional responsibilities for, or influence over, teaching and learning, I would suggest addressing, or continuing to improve, the structural problem of career advancement, recognition and reward for those with primarily or exclusively a teaching focus or role. UBC has recently established the role of full Professor of Teaching, with equivalent status to the research counterpart. Promotion to the post is based not just on outstanding teaching and significant service contribution, but also on demonstrated educational leadership. The latter may be evidenced in various ways, including scholarship and publications in the area of discipline-based pedagogical research. This has reinvigorated some in the teaching stream who had hitherto believed they had hit their career glass ceiling, as well as considerably increased the institution's capacity to move forward with significant teaching and learning initiatives.

Finally, to the Higher Education Academy I would applaud the commitment to continue the diverse programme of funded workshops, events and conferences that have formed and sustained the UK Physical Sciences education community since the very early days of the LTSN Physical Sciences Centre. However, I would also urge you to go further, to provide small travel grants to allow practitioners to attend and present at international discipline-based education conferences. There is now a substantial body of people placed in physical sciences departments in the UK who are engaged in discipline-based education research, clearly demonstrated by the vitality of UK events and conferences. Many would benefit from a small amount of extra support to transition from making purely national contributions to becoming more internationally aware and visible. I still recall my first attendance at the American Association of Physics Teachers (AAPT) Conference as a totally inspiring, slightly intimidating, hugely formative and tremendously valuable experience. Such networking builds capacity, supports collaboration and expands possibilities.

The relaunch of *New Directions* comes at an exciting time: despite challenging funding conditions and multiple competing pressures on people's time, there remains a growing capacity for dissemination of best practices and high-quality discipline-based education research in the UK physical sciences. It is a great platform on which to build and I look forward to following it over the coming issues.

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