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1. Introduction

Significant change in university teaching requires a "movement", says sociologist of higher education Parker Palmer (1992). Individual innovations need to gain collegial support and become fodder for widespread conversations, he argues. Then, one needs to establish reward structures to sustain this "movement" for change. This strategy is being applied in our Leadership project, funded by the Commonwealth Office for Learning and Teaching (OLT) -- *Fostering institutional and cultural change through the Australian network of university science educators,* which is funded for 2011-2013.

We aim to shift practices in university teaching of science and mathematics away from traditional, didactic, content-heavy delivery. Many worthwhile developments in university science teaching have failed to be adopted widely. That has made those pushing for such change all the more ready to attempt a new approach, or at least an approach that is new to them. Our initiative is a multi-pronged effort to develop the capacity of effective teachers to influence policy and practice within their schools, faculties, and institutions.

The capacity to influence is to be raised via action-learning projects that are now underway by teams of academic staff, academic developers, and associate deans (education). These efforts are being supported by communities of practice in the scholarship of teaching and learning (SoTL) that we are consolidating around areas of need – academic standards, laboratory and inquiry learning, and new media and communication. Project team members are being guided in cloaking their worthy undertakings in the language and rationale of key performance indicators of a dean and the legislated mandates seen by a vice-chancellor. The action-learning within these projects is thus not simply about teaching and student learning or even about building capacity in the scholarship of learning and teaching. It is about the exertion of influence up to the institutional level and potentially beyond.

This influence is to be undergirded by communal support, specifically by establishing a national network, the Science and Mathematics network of Australian university educators (SaMnet), which is being formed via our OLT Leadership project. SaMnet, launched in July 2011, has evolved from: (a) regional hubs focusing on science teaching and learning, such as the Sydney-basin Network of University Science Educators (SNUSE); (b) discipline-based, education special interest groups; (c) communities of interest formed around projects funded by the Australian Learning and Teaching Council; and (d) a national conference on university science teaching that has run for 18 years, the Australian Conference on Science and Mathematics Education.

This article outlines the issues that stimulated our effort as well as the strategies that we are pursuing and underlying rationale. We also outline early outcomes. A key objective of this project is to sustain the SaMnet movement beyond the two years of OLT funding. So, we seek from readers both constructive comment and identification of suitable academic developers and staff to help build and retain critical mass for SaMnet.

2. Why this combination of strategies?

The Australian Learning and Teaching Council (ALTC) and its predecessors have funded many

innovations in university science teaching (*e.g*., Carrick Institute, 2007), more than 40 at last count. This focus reflects the common critique, that science disciplines are plagued by content-heavy, didactic teaching that is primarily assessed by exams. Despite development of effective teaching practices, their dissemination and adoption has been seen to dissipate when funding ceases (*D-Cubed Newsletter*, 2011), with much of their potential impact yet to be realised.

One can characterise the sector as needing to engage in the stages of reform outlined by American sociologist of higher education, Parker Palmer (1992), whose work we referred to above. Stage 1 encompasses inventions of isolated individuals. In stage 2, those developments become the work of mutually supportive groups, which would include the SoTL communities of practice that we are forming. Stage 3 sees widespread public discussion of issues and questions emerging, such as through regional and national forums that we initiating or contributing to. Stage 4 involves establishing reward structures to sustain the change movement. Formation of such a movement requires distributed leadership to drive change and embed new policies and practices within departments, schools, disciplines, and institutions.

The time is ripe for such a movement as leaders of SaMnet and discipline-based science networks funded by the OLT have been invited by Carol Nicoll, then director of the ALTC and now director of the new Tertiary Education Quality Standards Agency (TEQSA), to have their members inform government regulatory initiatives (Carol Nicoll, personal communication, 22 August 2011). Such an invitation to align specific improvements in classroom practices with government mandates should enable innovative lecturers to improve their relationships with heads of school, deans, and administrators on up to offices in the Chancellery. The operative term here is "should enable", and the question is how this potential can be realised.

At the same time, a collective voice in this nascent movement is calling more loudly for reward structures for education-focused science academics. That was evident, for example, in a focus group run by authors Beames and Rifkin in Brisbane in February 2011. This thrust to push widespread adoption of agreed measures of scholarly teaching is supported by ALTC teaching awards and initiatives for peer review of teaching. The uptake of suitable reward structures will be hastened if they resemble the traditional reward structures of academia, which in the case of science involves a focus on refereed publication. To this end, SaMnet's leaders are identifying, developing, publicising, and supporting modes of refereed SoTL publication that will enable network members to advance.

Opportunities for collaborative relationships across the sciences, initiatives to document and spread local impacts, and appropriate and consistent reward structures require a support network. They are also necessary to sustain that network, or so Palmer (1992) has argued. Sustaining the network, and the movement that it enables, would permit academics in science and mathematics to speak more clearly as "one voice" in relation to government regulation and support. That is critical in times when not only are regulatory and budgetary measures being reformulated, but university enrolments in science and mathematics disciplines are generally in decline. At the same time, the agenda for inclusion of non-traditional university students may require substantial shifts in approaches to teaching and resourcing.

3. Theoretical framework

We are not focusing on positional power but at both individual influence and collective influence (*i.e*., Parker's "movement"). In this respect, we are using influence as a definition of "leadership" along the lines of Marshall's paper for the ALTC (2006). Furthermore, we are focusing on what Southwell and Morgan (2009) identify as "transformational leadership."

To gain a critical mass of "co-leaders", we are working across the sciences collectively. That seems appropriate given that Fairweather (2008) has found in the literature that good teaching strategies can be adapted readily to be effective in a range of science disciplines. In terms of social structure, we seek to support local action by teams with the communities of practice (Wenger, 1998) mentioned above, which are formed around key issues or themes. Aligning with these efforts are the OLT-funded discipline networks in biomedical science, chemistry, biology, and mathematics as well as self-initiated networks in physics and geosciences and our own national SaMnet network.

This sort of national initiative to support the generation of innovations and leadership of change has been pursued in the US by Project Kaleidoscope (PKAL) (2011). PKAL has been supported by the US National Science Foundation, as well as by charitable higher education foundations. It involves academics in "funded projects, national and regional meetings, community-building activities, leadership development programs, and publications that are focused on advancing what works in STEM education." After two decades, PKAL leaders have concluded (2011):

> What we are learning validates research on dissemination: how ideas evolve, emerge and are enhanced when like-minded colleagues pursue a common vision. This research also speaks directly to the impact of "near-peers" on influencing and persuading others to explore, adapt and assess approaches having demonstrable impact on strengthening STEM learning at all levels. The range and diversity of networks and collaborations now *making a difference* at the undergraduate level is remarkable; dissolving boundaries of discipline, geography, spheres of responsibility and career stage as they work to transform the undergraduate STEM learning environment in this country.

The PKAL strategy of working across science disciplines parallels our own plans. However, we are addressing a much smaller academic arena, 40 universities rather than the more than 5,000 institutions in the US, and we are providing various kinds of support, but no funding, for projects. It will be interesting to see how such differences in scale and differences in university-government relationships have an impact on the strategies undertaken.

Any national movement of this type relies on local initiatives, activities in the organizations where academics work. Case studies assembled by Tobias (1992) and Gibbs (2005) support the notion that sustainable change in university science teaching occurs at the departmental level. One can infer from Gibbs that departmental governance represents a key intermediate structure within a university. It lies between individual (and disciplinary) practice on the one hand, which Gibbs (2005) portrays as the focus of traditional educational development, and, on the other hand, institutional policies as well as practices of hiring and promotion. Gibbs (2005) notes:

> The kinds of networking, collating and discussion of practice and building functioning

> communities of practice that are associated with such change in individuals, are reasonably familiar to those involved in teaching development. However it also seems clear that the traditional educational development focus on changing individuals (or on individual practices or on individual courses) is also not enough. Without large scale strategic approaches, especially in crucial aspects of the teaching infrastructure, institutions have over the past twenty years changed much slower than have the environments within which they operate and have as a consequence run into severe problems that individual teachers feel powerless to tackle.

To foster insight into such institutional change, the SaMnet project is drawing on literature on change management and "organisational learning". Kotter's (1996) widely influential work on the stages of creating organisational change was employed by the ALTC-funded *Active Learning in University Science* (*ALIUS*) project. It represents a key starting point as the framework has resonated with ALIUS's science audience, which suggests that it should resonate with SaMnet's science audience, as well. That resonance has been confirmed in three workshop segments conducted by SaMnet to date.

The concept of "organizational learning" also appears relevant when one considers that not just individual practice but policies and practices of departments, schools, faculties, and institutions may need to shift. Research on organisational learning dates back to development by Argyris and Schoen (1974) of concepts of collective learning. Another benchmark is Senge's (1990) popularisation of key elements of organizational learning, including "systems thinking" and "dialogue processes". Rifkin and Fulop (1997) characterised important opportunities for collective learning as occurring when a "learning space" emerges, where relationships of power are suspended, as in peer networks. A complementary line of research and practice is in "appreciative inquiry" (Thatchenkery and Chowdry, 2007), whereby one fosters change by building on strengths, rather than focusing on problems. That is relevant for expanding on successes from previous ALTC-funded projects and the local innovations of individual lecturers.

4. Action-Learning Projects

SaMnet's action-learning projects are intended to enable innovative and effective lecturers to improve their own practices and the practices of colleagues and then ultimately to help change the culture of university teaching in science and mathematics. Case studies of practice locally and globally in educational settings suggest that action-learning projects by educators are a particularly effective means of stimulating change (OECD, 2001; Helen Wyatt, School Education Director, personal communication, 25 March 2011).

The action-learning projects being supported by SaMnet involve:

A. Multi-specialty teams -- A local team is assembled, with SaMnet's help if needed, constituting an innovative lecturer, a senior academic mentor, the faculty's associate dean (education or teaching and learning), and an academic developer. Not all team members need to come from the same university. In late 2011, teams coalesced when we invited proposals for action-learning projects. Proposals were submitted on a pro forma that identified the specialties that we felt each team needed, e.g., a view across the faculty or across the university or an historical sense of approaches that would not work. The proposal

also represented an outline of a team's project plan, and it called for identification of key stakeholders and the challenges of getting them on board.

B. Workshops -- Team members attend local workshops at least once a year for insights into pursuing their projects as well as to learn strategies for leading change. The local workshops, conducted in five capital cities, link project participants with colleagues whom they can meet face-to-face. As of 1 March 2012, we are mid-way through the first round of these workshops. Periodic national workshops are planned for May to August 2012 as teleconferences/Skype meetings. The specific aim is to enable members of teams with similar projects to connect with one another, *e.g.*, participants in the eight projects across the country in chemistry can talk and members of the four project teams focusing on first-year issues can engage with each other. Keeping face-to-face workshops local and national workshops online reduces cost and increases chances of sustainability. We go through the cycle of workshops twice, once in 2012 and once in 2013, with teams having two years to pursue their projects.

C. SoTL support -- Team members are being guided in authoring and publishing in two areas: (a) case studies on their educational strategies and (b) case studies on their efforts for organisational change. Editors of two Australian journals in the scholarship of teaching and learning are preparing to welcome these publications to enable project team members to earn credit in "the traditional academic reward structures of science".

D. No funding – Importantly, these action-learning projects are not funded by SaMnet. Some teams have already gained internal support, which signals the significance of the project to department, school, and faculty priorities. We are working with other teams to cultivate department, school, or faculty endorsement if not funding. The lack of funding from SaMnet is part of our aim to establish capacity-building activity that is sustainable beyond the two-year horizon of the OLT funding. In addition, we seek to make leading change part of the "day job" of key members of academic staff. That is what makes SoTL publication from these projects so important, as innovating and leading change can then be construed to be part of an academic's research time. Such research outputs should be particularly valued in teaching-intensive universities and in teaching-focused positions in research-intensive universities.

5. Outcomes So Far

We had a launch of SaMnet for a key target audience at the annual education conference of the Australian Council of Deans of Science (ACDS) in July 2011. That was a month before our OLT funding arrived, but nine months after we had formally started assembling ten key players from around the country into the project's steering committee (including former ALTC grant holders, associate deans, known SoTL scholars, and "rising stars"). The forty delegates at the ACDS conference assessed an initial draft of our application form for action-learning projects. That provided valuable input and alerted these stakeholders, mostly associate deans (education), about our initiative.

SaMnet was formally launched at the national Australian Conference for Science and Mathematics Education in Melbourne in September 2011, being presented in a plenary session to more than 100 delegates. That venue enabled members of SaMnet's steering committee to answer questions about SaMnet and the action-learning projects. A formal

call for proposals for action-learning projects followed presentation of SaMnet to the annual general meeting of the ACDS in mid-October 2011. By early December 2011, we had 21 successful proposals for projects involving 85 academics nationally across 15 universities.

These projects are based in Sydney, Canberra, Melbourne, Brisbane, Hobart, Adelaide, and Perth. They range from building links between mathematics and biology subjects in which that mathematics is to be employed to changing first-year laboratories in physics to a more inquiry-based approach.

Members of SaMnet's steering committee have provided constructive advice in response to the project proposals. Each one has also selected one or more projects for which they will serve as a "critical friend," a form of mentoring meant to represent an occasional "light hand on the tiller". They will thus be using their expertise where it can add the greatest value though they will not be driving the project. Leadership of the project remains within the action-learning team, which enables more individuals to gain capacity in day-to-day leadership, in handling the hurdles that often arise when seeking change within a school or department.

Our workshop series has begun, as noted earlier. The morning of each workshop focuses on having teams develop the next step in their project. It also addresses approaches to publishing on their efforts, such as considering research methodologies. The afternoon introduces insights on leadership from experienced leaders of change in university science, such as a former Pro Vice-Chancellor (Education). We also provide a first taste of principles of leading change from the management literature, such as Kotter's eight essential steps to implementing and embedding organisational change. These principles are presented in a form translated for an academic setting. Participants are asked to complete worksheets to determine the principle's or model's relevance to their own project initiative.

Workshop activities are designed to have members of a single team practice working with one another, to have members of different teams compare their approaches, rationale, and experiences, and to enable members at the same level (e.g., senior academic mentors) to be able to talk with one another. Workshop activities are predominantly participant-centred; no *PowerPoint* slides are employed during the day.

6. Conclusions

Formulating our multi-pronged effort has been a learning experience in itself. Each element has needed to support agendas ranging from the micro – such as existing educational interests among innovative lecturers – to the macro – impending government regulation and changing student demographics. We are seeking collaboration among people in similar roles in the same discipline as well as in different roles in order to extend capacity within project teams. We see the sciences and mathematics as having disciplinary differences but also common aims and challenges. For the individuals involved, we are drawing on altruistic values for serving students through wider adoption of effective teaching practices. We are also drawing on more personal drives for garnering the rewards of promotion, feeling a sense of belonging to a larger community, and enhancing one's capacity for taking on more satisfying work.

Our project evaluator has suggested that we should consider the project successful in stimulating 21 action-learning projects without providing funding for teaching relief or administrative support to the teams. An insight here is that there is already a notable measure of trust and good will in the science and mathematics teaching community and a certain readiness to "front up" and put in effort toward improving teaching as part of a national initiative.

The SaMnet effort to date has involved a time-consuming process of "ramping up," as the mutually supporting strategies that we are employing take some consideration, and illustration, for participants to comprehend fully. As with many such initiatives, we continue to wrestle with how best to implement the next step and how to articulate these steps amongst the demands of seasonal academic terms, *e.g.*, identifying when we can get attention to review a proposal, to talk with a "critical friend", or to submit an abstract for a conference presentation. One might conclude that we are not only aiming to enhance the leadership capacity of innovative lecturers, we are seeking to develop our own leadership capacities. In addition, we need to systematise the process of leading SaMnet so as to make it self-sustaining, essentially to find the resonances between the concepts of "succession" and "success." In this pursuit, we welcome your advice and your participation.

More information at: http://www.samnet.edu.au

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