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Using communities of practice to enhance interdisciplinary teaching: lessons from four Australian institutions

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Abstract

We report on the establishment of communities of practice at four Australian institutions and evaluate their effectiveness and durability as a means of building staff and institutional capacity for interdisciplinary teaching. A community of practice approach is a potentially valuable methodology for overcoming dynamics of fragmentation, isolation and competition within universities. The communities we established were anchored by a shared focus on the topic of climate change and they worked collaboratively to build relationships of trust and reciprocity between teachers in a wide range of disciplines. The aim of each community was to improve the teaching of climate change through enabling members to integrate diverse disciplinary perspectives, to teach collaboratively, to promote innovation through exchange and to demonstrate leadership within their institutions. The key factors that made our communities effective and durable are: (1) designation of two leadership roles, activator and facilitator, (2) provision for institutional autonomy in domesticating the model to fit local circumstances and (3) a pragmatic emphasis on opportunities for teaching innovation and leadership within existing administrative structures, teaching programs and workloads. We conclude that suitably designed and resourced communities of practice are a viable means of improving interdisciplinary teaching of complex problems by facilitating both staff development and institutional learning.

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Using communities of practice to enhance interdisciplinary teaching: Lessons from four Australian institutions

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We report on the establishment of communities of practice at four Australian institutions and evaluate their effectiveness and durability as a means of building staff and institutional capacity for interdisciplinary teaching. A community of practice approach is a potentially valuable methodology for overcoming dynamics of fragmentation, isolation and competition within universities. The communities we established were anchored by a shared focus on the topic of climate change, and they worked collaboratively to build relationships of trust and reciprocity between teachers in a wide range of disciplines. The aim of each community was to improve the teaching of climate change through enabling members to integrate diverse disciplinary perspectives, to teach collaboratively, to promote innovation through exchange and to demonstrate leadership within their institutions. The key factors that made our communities effective and durable are the 1) designation of two leadership roles, activator and facilitator, 2) provision for institutional autonomy in domesticating the model to fit local circumstances, and 3) a pragmatic emphasis on opportunities for teaching innovation and leadership within existing administrative structures, teaching programs and workloads. We conclude that suitably designed and resourced communities of practice are a viable means of improving interdisciplinary teaching of complex problems by facilitating both staff development and institutional learning.

Keywords: *community of practice; complex problems*; *facilitator, interdisciplinary; peer learning; climate change*

> *I get by with a little help from my friends.*
> John Lennon and Paul McCartney, 1967

Introduction

The teaching of complex problems in higher education is a complex problem in itself because it requires the collaboration of a wide range of academic disciplines that commonly exist in isolation from each other. Disciplines can differ markedly in terms of teaching methods, knowledge claims, curriculum content and organisational cultures (Brown, Deane, Harris, & Russell, 2010). Yet many university teachers are likely to have little awareness of teaching practices and curriculum content in disciplines outside of their own. In contrast, students commonly take units from several disciplines

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and are left to make sense of disparate, and sometimes conflicting, learning experiences in their own time. Disciplinary fragmentation poses a particular challenge to students in the context of complex problems on which many different disciplines converge, each with an important but disarticulated contribution to offer. The mismatch of real-world complexity and disciplinary specialisation in higher education has deservedly attracted criticism for failing to adequately prepare students to apply their learning to these problems in their professional and personal lives (Bangay & Blum, 2010; Brown et al., 2010; Schmitz, Stinson, & James, 2010). Conversely, studies have found that students with formal training in interdisciplinary learning are better able than their disciplinary counterparts to synthesise disciplinary contributions and thereby handle the emergent, ambiguous, contradictory and context-dependent nature of many social and environmental problems (Fortuin & Bush, 2010; Spelt, Biemans, Tobi, Luning, & Mulder, 2009).

Efforts to promote interdisciplinary student learning have tended to take the form of integrative programs situated outside of conventional disciplines (Franks et al., 2007; Golding, 2009). While offering students an integrated learning experience, these programs exist in isolation from the disciplines. There are relatively few examples of teachers incorporating interdisciplinary content and skills into discipline-based programs. This is to be expected because the barriers to disciplinary teachers collaborating are many and both substantive and procedural. Substantive barriers include colleagues from different disciplines having limited common ground in terms of shared language and professional norms. Procedural barriers include the administrative marginalisation of teaching collaboration between disciplinary units through workload allocation and budget disincentives (Kember, 2009; Pharo & Bridle, 2012; Russell, Wickson, & Carew, 2008). University teaching has long been regarded as a highly individualised practice (Ortquist-Ahrens & Torosyan, 2008), in contrast to the collaborative nature of many research practices that involve working directly with peers to solve problems, identify shared goals, and exchange different perspectives and experiences (Åkerlind, 2011).

To overcome barriers to interdisciplinary teaching and learning, we established communities of practice at four Australian universities. The participating institutions were Murdoch University (MU), University of New South Wales (UNSW), University of Tasmania (UTas), and University of Wollongong (UOW). The project was supported by an Australian Learning and Teaching Council (ALTC) grant titled 'Demonstrating distributed leadership through cross-disciplinary peer networks: Responding to climate change complexity' (Davison et al., 2012). It built on a successful 2008 pilot project at UTas (Pharo et al. 2012).

The broad aim of our four communities of practice was to improve teaching of climate change by bringing together teachers from a wide range of disciplines to integrate diverse disciplinary perspectives, to teach collaboratively, to promote innovation through exchange and to demonstrate leadership within their institutions. The majority of these teachers had little or no prior professional engagement with each other. We sought to establish whether fostering informal connections across formal institutional boundaries advanced interdisciplinary teaching, peer-led staff development and institutional learning.

This paper describes the establishment of these four communities of practice and evaluates their effectiveness and durability as a means of promoting interdisciplinary teaching. The authors are members of the multi-institutional project leadership team and the paper draws upon the process of formative reflection and evaluation embedded in every phase of the project. Reflective and evaluative data was collected through the sharing of reflective journals, regular team meetings, preparation of multiple progress reports and a final report, the collaboration of an external project evaluator, the input of an international reference group, the presentation of conference papers and the preparation of regular newsletters for stakeholders. In addition, the paper draws upon semi-structured interviews conducted with the facilitator of each community of practice and other community members. These interviews explored the successes and challenges encountered by participants in developing their interdisciplinary teaching practice and to initiate institutional learning. Partial transcripts were prepared and analysed in relation to themes identified as part of the wider reflexive processes embedded in the project.

Establishing Interdisciplinary Communities of Practice

There is much confusion over the concept of 'interdisciplinarity' in the literature (Davies & Devlin, 2007). We take interdisciplinary approaches to explicitly draw together and integrate different forms of knowledge to explore a problem and produce insights that are more than the summing of disciplinary parts (Klein, 1990, 2005; Lattuca, 2001). Transdisciplinary approaches encompass interdisciplinary synthesis but extend beyond it by integrating academic knowledge with non-academic modes of knowing (Chettiparamb, 2007). Multidisciplinary approaches, in contrast, are not interdisciplinary and rest on an additive collection of disciplinary perspectives that lacks synthesis (Chettiparamb, 2007; Huutoniemi, Klein, Bruun, & Hukkinen, 2010).

A community of practice methodology was adopted in this project because the prime barrier to interdisciplinary teaching was identified to be a lack of teacher collaboration in the face of disciplinary fragmentation, isolation and competition. There exists an extensive theoretical and practice-based literature advocating communities of practice as a collaborative means for promoting

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learning within educational and other organisations (Barab, Barnett & Squire, 2002; Li et al., 2008; Sherer, Shea, & Kristensen, 2003; Tight 2004; Viskovic, 2006;Wenger, 2000). In the context of higher education, intentional communities of practice have also been described as 'faculty learning communities' (Cox, 2004) and 'teacher networks' (Lieberman, 2000) and provide a valuable corrective to the isolation experienced by many academic teachers. Involvement in such intentional communities needs to be voluntary and arise out of the desire of teachers to communicate passions, aspirations, frustrations and confusions (Sherer, Shea, & Kristensen, 2003; Viskovic, 2006; Lefoe 2008). The self-organising nature of communities of practice ensures that their composition and operation encompasses a good deal of diversity, depending on their local context, membership, intended function, whether they are self-governed or overseen by a dedicated facilitator, and their relationship to formal resource allocation and management processes (Cox, 2004; Ortquist-Ahrens & Torosyan, 2008).

Communities of practice are defined by their capacity to promote what Wenger (2000) calls social learning – the exchange, acquisition and evaluation of knowledge that occurs in the participative context of a group of practitioners. It is useful, however, to distinguish between first order and second order understanding of this definition. First order communities of practice pervade the production, transmission and questioning of knowledge in all aspects of social life in largely implicit or tacit ways and are an integral part of the creation and maintenance of institutions. In a second order sense, the sense in which the term is used in this paper, communities of practice describe a specific methodology for bringing about change through learning. In this sense, a community of practice is an overt means of harnessing social learning so as to facilitate transformation in the practices that constitute the community. The emphasis on practice in this methodology thus encompasses two meanings. First, there are the historically and politically structured actions that establish the common ground of the community– its *context*. Second, there is the practical change that gives the community its shared purpose– its *intention*. Appreciating both meanings of practice is necessary to appreciate the ways in which communities of practice are internally cohesive, bounded and introspective and yet are also capable of leading wider change. In the case of the project described here, communities of practice were established in the context of shared practices of academic teaching with the intention of deepening and extending possibilities for interdisciplinarity within these practices.

We established communities of practice with the intention of promoting interdisciplinary teaching on climate change. Four key elements characterised our approach:

(1) A self-nominating teaching academic acted as an 'activator' (or catalyst) in forming the community of

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practice. The activator absorbed the workload into their academic position, being motivated by their passion for teaching innovation, their concern about climate change and the possible career rewards associated with gaining external grant funding and subsequent publications.

(2) A paid 'facilitator', employed one day per week from the grant, took on a role that included some combination of curriculum design support, collecting teaching resources, facilitating cross-disciplinary communication between team members, and documenting community activities. The facilitator had a substantive role in pedagogical practice through helping community members to develop common language and common purpose in teaching collaboratively across disciplinary languages, sub-cultures and classroom habits (Ortquist-Ahrens & Torosyan, 2008).

(3) At least six teaching academics were recruited, covering as wide a diversity of disciplines and teaching programs as possible. Each participant possessed a desire to address one or all of the three focal points of the community: climate change teaching, interdisciplinarity, and collaborative teaching. Participation was voluntary and recruitment was carried out by the activator and facilitator.

(4) The initial focus of each community was to build group capacity for collaborative learning. Participants shared the desire to bring about interdisciplinary teaching innovation within existing institutional structures and participant workloads,

While all four communities shared these foundational elements, each was allowed considerable autonomy to ensure their collaborative learning was best suited to local circumstances and membership. Emphasis on voluntary participation, informal relationship building, consensus decision-making and the sharing of leadership roles within communities provided ample opportunity for all members to show initiative and take responsibility for shared outcomes, in keeping with the literature on communities of practice (Cox, 2004; Sherer et al., 2003). All four communities had a core of active members, as well as a peripheral group who maintained contact by coming to meetings or responding to emails, without directly contributing to group activities such as teaching projects, papers and reports.

Institutional settings

The participating institutions vary in their disciplinary structures. UTas and UOW are dominated by discipline-based schools. UNSW has a similar structure to UTas and UOW but, in the context of climate change education, has an Institute of Environmental Studies, located in the Faculty of Science, that is a hub for networking amongst staff with environmental research and teaching interests. At all three institutions, schools are under pressure to increase their student enrolment, because school income is directly linked to enrolment numbers. This directly cultivates intra-institutional competition between disciplines and schools for student enrolments and acts to reinforce disciplinary 'silos' (Pharo & Bridle, 2012). This financial competition represents a powerful barrier to teaching

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collaboration between disciplines, especially in the context of the increasing workloads over recent years (Jacobs, 2004).

MU was different to the other participating institutions in that the founding of this university in 1974 had the explicit aim of promoting interdisciplinary teaching and research. While subsequent restructuring of the university has weakened many of these interdisciplinary structures, the university remains more equipped to support interdisciplinary teaching than many in the sector. Both the activator and facilitator of the community of practice at MU were within a small interdisciplinary school and were already collaborating with other staff doing environment-related teaching in other schools. This led to the establishment of a community in which many members were already engaged in interdisciplinary teaching.

Collaborative practice

Each of the community of practice activators and facilitators were careful to allow time for members to get to know each other in informal settings. This time spent exchanging ideas, food, experiences, knowledge and other 'gifts' prior to beginning on the substantive ambitions of the project, assisted with the building of rapport and trust within the group. However, time does not by itself generate trust within communities of practice. Shared desire, or strongly affective motivation, contributed to the good will and reciprocity that characterises collaborative learning.The voluntary participation of members and the focus of the project ensured that two desires were widely shared by participants. First, many members experienced a desire—a 'craving' as one participant put it— to overcome a debilitating history of institutional isolation. Second, many members shared profound concern about climate change and a related conviction about the practical imperative of improving climate change teaching.

The emphasis on building trust from the earliest moments of the communities of practice was vital to ensuring community members were able to robustly deliberate points of difference and to air confusions and uncertainties as well as convictions. Such tolerance and mutual-respect was subsequently maintained through continued emphasis on the role of the group in defining and creating sociable settings for activities such as meetings, developing teaching materials, co-teaching, exchanging teaching methods, collaborating with students.

Figure 1 indicates the way in which, over time, the density and complexity of internal relations increased within the communities as practical projects knitted the group together in new ways. How this played out in practice to influence student outcomes is best described in the following examples. 1) At UoW in 2010, community of practice members co-designed a new teaching activity for first

year science students and third year law students. Working lawyer/expert scientists teams, students responded to a fictitious scenario involving issues of coastal development, climate change, and endangered species law. They were asked to argue for or against the coastal development in a mock trial. The standard of legal argument from the law students was excellent. The high quality of research from the science students was a big improvement on their lacklustre performance in the library research exercise of previous years. The collaboration between community of practice teachers meant that all students obtained a deeper understanding of the approach of other disciplines and a better sense of the role and skills of their own discipline.

> 'Students said that they wanted teachers to help them put together the complexity of climate change and felt frustrated by the lack of communication between their different classes, and even between different teachers in the same class.' L2, UOW

The UoW initiative directly addressed this feedback. It was labour intensive to create and would not have happened without the support of the facilitator. The end result was much improved student outcomes and more positive student feedback.

2) Teachers in the UTAS community of practice began with an informal 'problem relay' approach of transferring student outcomes and learning between classes in different disciplines. This approach required community members to inform each other about their current teaching and to work together to identify areas of complementarity. For example, a literature review prepared by zoology students was then passed on to geography students, who built on this information to develop a scenario that was at the centre of a marketing pitch developed by business students studying entrepreneurship. This model of using teacher collaboration to enhance possibilities for student collaboration across disciplinary boundaries was later extended by community members in initiating a collaboration between teachers and a group of students drawn from a range of disciplines in the task of designing a new interdisciplinary and collaboratively taught unit on climate change. This unit was introduced in 2010 and has since provided a formal structure in which community members can co-teach. As one community member described it,

> 'I craved an interdisciplinary space and feel that it is so much more conducive to constructive exchange of ideas because there is no single preconceived ideal and more freedom to try new things. The community was welcoming and was the only space on campus where these types of teaching discussions were facilitated and encouraged.'M1, UTas

At MU, the most interdisciplinary university in our project, participants also reported a need for greater dialogue with colleagues and that before the project they had relatively little knowledge about what other people were doing around climate change in other parts of their institution.

> 'I met people I did not know from across the University and was able to hear what they are doing. I was able to talk to a colleague about how I might run a climate change exercise in my unit. I felt more able to ask for that discussion because of the community.' R2, MU

Sustaining collaboration

Even with self-nominating membership, collaborations in academic teaching tend to be fragile and ours were no exception. There were many barriers to collaboration outside of conventional organisational units. Our communities of practice operated at the margins of the workloads of members, given the relatively low priority afforded to teaching and teaching scholarship in general (Chalmers, 2011). This marginalisation was compounded by the experience of managing excessive workloads. For example, one community member reported that:

> 'Finding the time is difficult because climate change is not a major part of my work and I don't have the synergies that others have between work and the community.' C4, UNSW

Another member said that many members tended not to integrate this commitment into their workload, but rather volunteered private time for an endeavour they saw as inherently worthwhile.

> 'Mostly people are involved in the community in their spare time or as an extra commitment. There are a lot of work pressures reducing the ability of members to be as involved as they would like to be.' N1, UNSW.

Through the experiences of the four communities, we found that some features worked particularly well to confront the potential of marginalisation of this project in busy academic lives. They were the importance of the paid facilitation position, having large memberships, recruiting members whose job lines up with the aims of the community, and embedding interdisciplinary teaching in units. Each of these is discussed in more detail below.

The importance of the facilitator

The constant threat of marginalisation was partially addressed through the role of the facilitator, who was employed to build relationships between community members, often acting as a go-between in

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the exchange of ideas and activities. Each facilitator was responsible for logistical and administrative support, such as booking venues and taking notes at meetings. More importantly, their role was to help to facilitate and mediate cross-disciplinary negotiations within the community and help bring ideas to fruition. While some community of practice facilitators might fulfil a primarily logistic role, our facilitators were important in mediating disciplines and catalysing discussion as described by Ortquist-Ahrens and Torosyan (2008). Our communities were different from those described in the literature in that the facilitator was closely supported by the activator and these two roles were reasonably fluid. There was considerable exchange of roles depending on personal preferences, project demands and the availability of each at any given time. For example, one activator observed that:

> 'Having two people fulfilling overlapping roles meant that we didn't have all our eggs in one basket. There has been a lot of change in personnel and membership over the years, including the facilitator. Having the second person around provided continuity and that was important for keeping on top of paperwork like ethics applications and reporting, as well as for the intellectual side of the project.' E3, UTas

This delineation of two partially overlapping roles gave the communities additional flexibility in responding to the pressures faced by the community, especially when one of these people was away from their normal duties, which was a relatively common occurrence. This resilience proved important, given that losing members is such a common obstacle for communities of practice (Eisenman, Hill, Bailey, & Dickison, 2003).

Flexible membership structure

Another way in which one of our communities of practice were able to maintain momentum in the face of heavy teacher workloads was to have considerable flexibility in determining the optimum size and structure of each community's membership. For example, the UNSW community of practice had about 40 members, including graduate students and media experts. This large pool of people meant that there was always about 10-15 people at each face-to-face meeting to feed in ideas and make up a quorum for pushing ahead with decisions. The smaller communities, of around eight people, at the other institutions meant that ensuring a critical mass of people to attend face-to-face meetings was sometimes struggle, although the UoW community of practice in particular found information technology solutions effective in addressing this issue. In general, a smaller membership of strongly committed members enabled close working relationships. Such relationships were evident in the pairs and small groups of members who collaborated in implementing teaching activities directly in their

classes. While smaller, these other three communities of practice also had a peripheral group of interested academics who remained informed about community activities via newsletters and emails.

Recruiting key people

We found that people in integrative roles within the institution were important nodes in our communities. Members with campus-wide networks in relation to teaching were particularly valuable and included academic developers, sustainability officers, student union representatives and communications officers. They had an overview of the university not shared by those embedded in the disciplines and often the aims of the community were closely aligned with their other interests that they were able to put in additional energy and resources to the project. Students who held university positions, such as the Student Representative Council, were particularly important community members at UNSW because of their student-centred knowledge of the university and their leadership abilities.

'Being involved with the project gives me an opportunity to become involved with my education, to be active in an issue that concerns me, and the community provides me with contacts from other areas of the university including academics and other students. This is extremely helpful for other projects I am working on around uni.' Member J3, UNSW

Also at UNSW, the Media & Communications office was able to offer skills that were attractive to teaching academics.

> 'The community brings together discipline experts and creative communicators. This is a powerful combination, and with these complementary skills, we can raise awareness and produce engaging materials in a way that are not possible if we work independently.' M2, UNSW

> 'The connection to UNSWTV has been very helpful and exciting. Even though climate change is not a major part of my work, the animation materials from UNSWTV will be very useful.' C1, UNSW

These key members were important as leaders and meant that UNSW operated most successfully of the four institutions in terms of distributed leadership, as defined in Lefoe (2010). All communities took pains to make it clear to their community members that anyone, individually or in sub-groups, could direct the community. There were many opportunities for changing and shared leadership, depending on the nature of the specific task being undertaken, the competencies of members of the

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group and the constraints and opportunities encountered by members at any given time. In practice, leadership usually fell to the activator and facilitator, particularly among the smaller communities at UOW, UTas and MU. However, at UNSW the activator and facilitator were effectively joined by these key members, who helped inspire other members as well as influence students, senior managers and the public.

Embedding interdisciplinary innovation in teaching workloads

The marginalisation of community of practice activities within the work lives of participants was reflected in the difficulty of coordinating highly constrained diaries, finding convenient venues and navigating the many significant differences between schools. In response, the communities of practice deliberately focussed on identifying opportunities for interdisciplinary innovation within the existing teaching responsibilities and programs of community members. Ironically, the most durable interdisciplinary initiatives in the project have been those relating to the establishment and enhancement of interdisciplinary climate change classes within existing degree programs, rather than the informal connections that our communities initially sought to establish. However, informal connections were a critical step towards the more formal embedding of interdisciplinarity in existing or newly established units.

Interdisciplinary foundation units are one way in which MU achieves interdisciplinary learning. The other institutions sought to move at least some units in this direction, by connecting up disciplinary specialists. UOW improved an existing interdisciplinary climate change unit by bringing in disciplinary specialists to teach areas such as human geography, economics and policy that had previously been delivered by teachers outside those areas of expertise. At UTas, a new broad, third year climate change unit was developed and taught into by a variety of community of practice members.

For both the UOW and UTas units, the ability to get a diversity of students together in one class and design assessment around interdisciplinary engagement meant that students had opportunities to think deeply about what knowledge and skills might be needed to tackle particular aspects of the climate change challenge. While the focus of this paper is not directly on the student learning that resulted from the teaching collaborations, teachers in these units frequently observed students demonstrating that they had achieved important insights into why climate change was such an intractable interdisciplinary problem. Many students demonstrated that they were able to integrate knowledge from disciplines that were quite distant to their major studies (Davison et al., 2012).

Implications for higher education sector

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This project was designed to respond to two systemic challenges faced by the higher education sector in Australia. First, we respond to the need for universities to translate long-standing recognition of the value of interdisciplinary teaching into classroom practice (Franks et al, 2007). In this way, our project contributes to the capacity of universities to lead professional, public and policy responses to the wide range of social and environmental problems that are interdisciplinary in nature, such as climate change. Second, we responded to the need for universities to develop more supple institutional structures capable of adapting to an increasingly dynamic context. This context includes changing student cohorts and expectations, diversified and mutable career structures, higher education policy reform and new international opportunities and challenges. The pragmatic and flexible nature of the model is discussed further below.

Pragmatic approach

A characteristic of our model that makes it widely applicable across the sector is its pragmatic approach to structural impediments to interdisciplinary teaching. This pragmatism is evident in the way in which the model enables the identification of opportunities and efficiencies for teaching leadership within existing administrative units, curricula, degree programs, and staff workloads. The model works to strengthen and embed teaching collaboration across divides by creating collegial relationships that enable institutional culture change within existing structures. Supporting links between clusters of teachers and having a multitude of inter-related initiatives has been found to be important in enabling cultural change in universities (Roxå, Mårtensson, & Alveteg, 2011). Our intentional communities of practice contributed in vital ways towards embedding interdisciplinary learning as a core generic competency that will enhance the professional lives of graduates.

A key barrier to the implementation of interdisciplinary curricula in Australian universities has been an unfortunate perception that disciplinary and interdisciplinary approaches are clearly distinct and, in some cases, antithetical. Our approach, in contrast, is built on understanding that disciplinary and interdisciplinary teaching exists within a continuum of pedagogical approaches, that also includes multidisciplinary and transdisciplinary approaches (Davies & Devlin, 2007). Our model takes advantage of the fact that disciplinary and interdisciplinary teaching can be complementary. While some community members were not trained in any one discipline, for example within the field of environmental studies, the majority identified with conventional disciplines and sought to integrate interdisciplinary learning within predominantly disciplinary teaching programs.

Flexible approach

The flexibility of our model meant that communities could be shaped to different institutional contexts. While all communities shared generic features, there was considerable variation in the

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strength of the barriers around interdisciplinary collaboration among the four institutions, with MU having structures that were most favourable for interdisciplinary collaboration among teachers, and UOW and UTas being the least favourable. These latter two universities have highly disciplinary forms of internal organisation that create impediments. This includes the siloed structure of course design and administration; the funding model for student enrolments; and the lack of a general education or preparatory structure for incoming students (Pharo & Bridle, 2012). By having autonomy, the activator, facilitator and members of each community could take advantage of opportunities and existing strengths in deciding how best to promote interdisciplinary climate change teaching. Having the flexibility to be able to take advantage of opportunities has been found to be important in managing change in university teaching (Pharo & de Salas, 2009).

Conclusions

Based on our experience, we want to suggest three main conditions for successful communities of practice, that address the challenges of structuring and coordinating collaborations so that they will endure:

- Acknowledge and integrate disciplinary approaches: We established leadership and facilitation roles as a precondition for integrating the work of members. But in doing this, we explicitly acknowledged the importance of the disciplines and the need to work within, rather than threatening, existing structures as a way to make incremental improvements in offerings to students. This is important to acknowledge because moving the boundaries within an institution may simply create new obstacles and our communities of practice are designed to work across any institutional barriers.

- Link participation to a common desire for particular outcomes: In our project, participation among members varied, but was strengthened by our focus on climate change, which provided conceptual coherence and ensured passionate participation. The values, intentions and purpose of each community were clear to all members, and the social learning desired by the community came about through this strong focus. Making public commitments, exchanging 'gifts' within the community, and having 'intentional conversations' about climate change teaching practice were all important in bringing about trust between participants (Ford & Ford, 1995).

- Establish enduring coordination arrangements: Both the facilitator and activator played key coordination roles by having oversight of all the ideas and activities within the community. The facilitator was particularly important in connecting up teachers, either by organising meetings or simply making others aware of what peers were doing. This was a key outcome of our project and different to many of the communities of practice described in the literature. We cannot emphasise enough the importance of the paid facilitation role in sustaining the community and our experiences showed that withdrawing that support.

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We implemented intentional communities of practice at four universities to promote interdisciplinary climate change teaching. We contribute to the literature on interdisciplinary learning, by acknowledging the importance of working within existing structures and recognised the vital role disciplines can play in embedding interdisciplinary learning as a core generic competency. We were able to introduce and support people with compatible interests through the creation of two partially overlapping leadership roles: activator and facilitator. By having four communities with different features and contexts, we learned that communities with committed and flexible membership were robust, and that it was advantageous to involve members whose interests were at least partially aligned with the community, such as sustainability officers, communication brokers and student councillors. Our practical recommendations are intended to help others implement modest changes that can make a big difference to the interdisciplinary learning that teachers are able to offer students.

Our experience of communities of practice anchored around the theme of climate change suggests that many other complex problems are likely to suit interdisciplinary teaching collaboration because they demand multiple analytical perspectives and context-dependent responses. The communities fulfilled a desire for teachers to be less isolated in tackling complex social-environmental problems, like climate change. Our teachers strengthened existing interdisciplinary teaching by forging new relationships with disciplinary specialists and in creating new interdisciplinary teaching initiatives. Our model demonstrates the capacity for communities of practice to operate in a variety of teaching contexts and complements existing forms of concentrated, top-down leadership with forms of distributed, collaborative leadership.
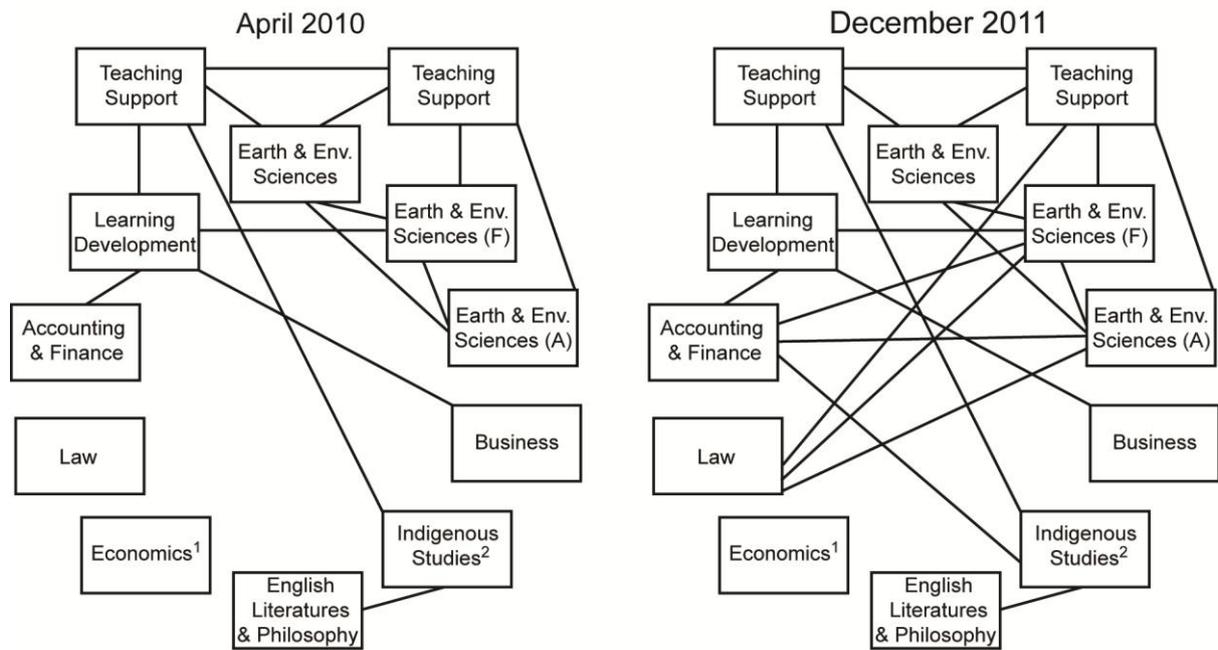
Figure 1. Change in teaching connections between academics involved with the UOW Community of Practice between April 2010 (when the UOW community of practice was established) and December 2011 (the conclusion of the ALTC funding). Solid lines show where academics had direct involvement in each other's classes, either through course development, joint activities between the students, or guest lectureship. Teaching support staff sat outside the community but assisted with these endeavours. The UOW community of practice facilitator (F) and activator (A) are indicated. 1. Retired, non-teaching academic conducting research into networked communities.

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