Journal for Education in the Built Environment, Vol. 7, Issue 2, December 2012 pp. 63-83 (21)

ISSN: 1747-4205 (Online)

Education for Climate Change Adaptation – Enhancing the Contemporary Relevance of Planning Education for a Range of Wicked Problems

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Abstract

Planning education involves engaging students in many 'wicked' planning problems of which climate change is a particularly testing example. This paper demonstrates that by thinking about climate change problems for urban and regional places, educators are reminded about the importance of some more generic but essential capabilities required of planners in dealing with a range of challenging problems. Based on the experience of reviewing and 'renovating' the University of Tasmania's planning programme to embed education for climate change adaptation, this paper: (i) reflects on such a process; (ii) describes the application of specific pedagogical values and approaches to the education of planners for climate change adaptation in the university's planning programme; and (iii) demonstrates how their application can facilitate improvement in education for other core planning capabilities. Among the pedagogical approaches embraced are: problem-based learning, adaptive learning and self-reflection, networked learning, critical thinking, linkage of theory and practice, and adaptation planning skills. Ultimately, the application of these approaches has not only addressed the need to incorporate education for climate change adaptation, but has also improved the capacity of the planning course to develop competencies relevant to planning for a range of challenging contemporary problems.

Keywords: Climate Change Education, Climate Change Adaptation, Planning Education, Planning Skills, Planning Pedagogy

Introduction

Efforts to incorporate climate change considerations into planning coursework represent an opportunity to more generally reconsider planning education, specifically its content, approaches and the essential capabilities required of planners. Planners are obliged to deal with a range of challenging or 'wicked' problems, climate change being just one example of these, albeit that it has been described as a 'super wicked' problem (Levin *et al.,* 2012, p.124), and may therefore make extraordinary demands on planners. While the focus on planning education around this issue has long concentrated on the mitigation of carbon emissions from human activities, it has only been in recent years that planning education has begun to recognise the significance of planning for the management of climate change impacts and facilitation of adaptation at the local and regional scales (Ruth, 2006).

The term 'wicked problems' was formerly pronounced in the 1970s (Rittel and Webber, 1973) to describe the difficult social problems challenging urban planners and public policy makers at the time. The problems were described as ill-formulated ones, confusing or complex, or arising from situations where there were many stakeholders with conflicting values. The term is relevant today with a number of public policy and planning problems demonstrating challenging and complex contexts, such as: planning for an aged society, population change and migration, food security, sustainability and climate change. These examples are marked by ambiguous problem definition, scientific uncertainties, and multi-dimensional solutions in which planners have a part to play in consort with other professions. Indeed many of these planning problems also overlap in relation to each other, requiring both multi-beneficial and interlinked problem solving (Figure 1).

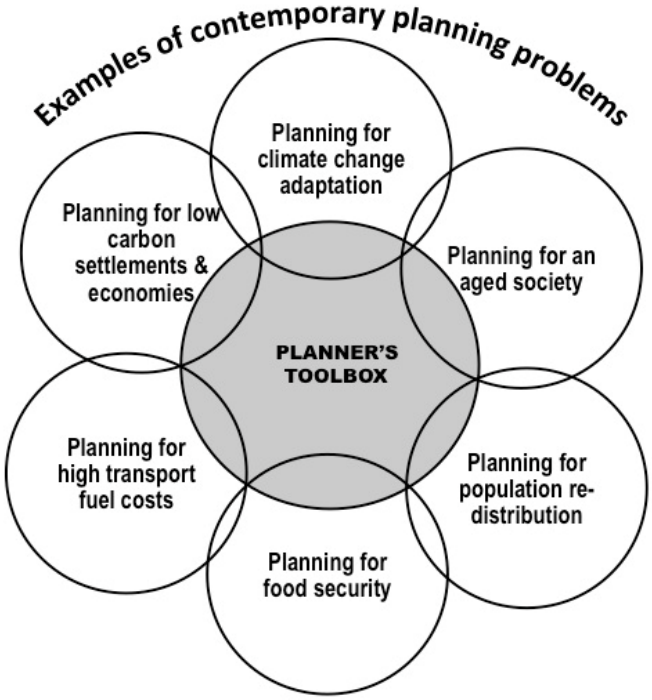

Figure 1 Examples of contemporary, interlinked, and often 'wicked' planning problems

This paper: (i) reflects on the experience of the University of Tasmania in renovating its planning programme to embed climate change adaptation education in the context of its complex problem setting; (ii) describes the application of specific pedagogical values and approaches to the education of planners for climate change adaptation in the University's planning programme; and (iii) demonstrates how their application also facilitates improvement in education for other core planning capabilities and contemporary planning issues.

Evolving Planning Competencies in Planning Education for Climate Change

In thinking about human-induced climate change and its ramifications and relevance to planning, the wicked problem can be described in terms of: its global nature, its local ramifications across different temporal scales, the complexity and interrelatedness of the impacts and their solutions, and the various degrees of knowledge and certainty around the science of global to local ecological, social and economic implications.

Planning for climate change invariably requires dealing with uncertainty and evolving complex systems. Society and adaptation policy and planning settings face continuous evolution on a number of fronts, including adaptation technologies, strategies, networks and structures (Rammel and van den Bergh, 2003). Innovative strategies to cope with emerging anticipated, unexpected, indirect, non-linear, and cumulative climate change implications will be required. Indeed in the context of weakening prospects of prompt mitigation and an enhanced likelihood that the world will experience 4°C and more of global warming (rather than 2°C), Stafford-Smith *et al.* (2011, p.204) alert us to the increasing possibility that planners will be required to consider pathways to quite radical change, such as the need to consider the long-term viability of some settlements, transport routes and infrastructure sites, planning for either their defence or ordered abandonment and the social implications of these. They argue that this will likely mean that the practice of incremental planning will be insufficient and that transformations via developing deliberate adaptive pathways will be necessary. This will also require planners to develop their capacity for adaptive learning.

Education for climate change adaptation is therefore concerned with: (i) the development of adaptive capacity or increasing the ability of individuals, groups or organisations to adapt to climate change and (ii) implementation of adaptation decisions (Adger *et al.,* 2005). As professionals, planners will be required to contribute to:

- reducing the sensitivity of built and natural environments and their communities to climate change;
- changing the exposure of built and natural environments and their communities to climate change; and
- increasing resilience of built and natural environments, communities and planning systems to cope with, adapt to, and transform, in response to impacts and changes associated with climate change (Lyth *et al*., 2007).

In support of this context and requirements, planners will need a specific knowledge and skillset, including having a minimum grasp of climate change science, developing skills to

understand the complexities and uncertainties of climate change, and acquiring an appreciation of systems thinking.

Among the generic competencies for a range of built environment professions noted by Lyth *et al*. (2007) are increased foresight and futures thinking, critical thinking and reflection, systemic thinking, and participative decision-making. Planners will need to be able to think laterally and engage with creative ideas outside practice norms. This implies being able to work in cross-disciplinary teams in order to understand and collectively solve problems related to climate change. From a professional practice perspective, planners should be able to apply a range of specialist practical skills related to risk and vulnerability assessment, and tools to assist futures and strategic planning, for example (or at least have a sufficient appreciation of these skills to know when to recruit practitioners with relevant expertise and can interpret their results).

As a consequence of these new demands, there will necessarily be changes to form and content of planning education as well as to the thinking skills and work practices that curriculum must foster in students. It will not be sufficient to deliver courses that are full of information dissemination and knowledge development material and there is unlikely to be room for the breadth of information ideally required in planning courses. Consequently, the pedagogies used to implement curriculum and coursework delivery methods may need to be rethought, while planning educators will be asked to establish learning environments that model the necessary perspectives, thinking and practical skills, and work practices that are consistent with new pedagogies.

Evolving Planning Courses

As Hamnett (1999, p.6) points out, changes to programmes of planning education are inextricably linked to changes occurring in the world of planning practice and reflect to a considerable extent the continuing efforts of the planning profession to remain relevant. Frank (2006) likewise refers to the continual need for planning educators to reflect on the relevance of planning programmes based on societal needs and ideas, while Lyth *et al*. (2007) consider the responsibility of planning educators to review and develop their programmes (and thus new generations of planners) in anticipation of emerging and future issues.

Sustainability, social equity and climate change have been recognised by the United Nations Human Settlements Programme (2009, p.185) as three global challenges that planning schools around the world need to ensure they discuss effectively. According to the same report only one third of planning schools globally addressed climate change in their planning education courses (United Nations Human Settlements Programme, 2009, p.191). However, the report does not say what elements of climate change tend to be addressed in these courses and how extensive and relevant the education is to the development of planning competencies. Indeed there is very limited research available about pedagogical guidance for climate change adaptation planning education.

As the Australian planning profession began to acknowledge the significance of climate change education for planners and the growing need for skills and improved knowledge in

the field (Planning Institute of Australia Queensland Division, 2002; Lyth, 2006; Lyth and de Chastel, 2007), a few university planning programmes were also beginning to enhance their inclusion of education for and about climate change (Lyth *et al.,* 2007). As one of the early movers, the University of Tasmania (UTAS), acknowledged the need for increased attention to be paid to education for both climate change mitigation and adaptation through the periodical review process of its environmental planning coursework programme. A government grant from the Australian Greenhouse Office (now the Department of Climate Change and Energy Efficiency) under its inaugural Climate Change Adaptation Skills for Professionals Programme enabled the formalisation of curriculum review and development in the area.

Approach

Specifically, the Climate Change Adaptation Skills for Professionals Programme grant was awarded for the purpose of developing curriculum materials for climate change adaptation planning and to trial integration or mainstreaming of the materials into the University's environmental planning programme. The trial occurred in Semesters 1 and 2, 2009 and involved students studying environmental planning and management masters programmes. In line with the teaching and learning philosophy informing the project, the trial incorporated problem-based learning exercises, with the aim of introducing students to adaptation planning skills and competencies.

In this paper, we critically reflect on our experience of mainstreaming climate change adaptation into planning education and canvass the relative merits of several approaches to such integration. We also explain the relevance of a range of pedagogies – problem-based learning, adaptive learning and self-reflection, networked learning, critical thinking, and linkage of theory to practice – in equipping planners with the skills and capacities required to operate not only in climate change contexts but also in other situations characterised by change, complexity and uncertainty.

Our reflection is 'critical' (Fisher, 2003, p.314) in the sense that it is located in a wider planning context related to a range of emerging and complex planning challenges as well as global sustainability. And it is critical from the perspective that a main aim of the paper is to promote a planning education paradigm that endorses pedagogies and associated learning attitudes and capabilities appropriate to the demands of messy and wicked problems.

Mainstreaming Climate Change Adaptation into Existing Coursework

About the University of Tasmania's planning coursework programme

The University of Tasmania's postgraduate Environmental Planning courses (Graduate Diploma and Masters) have been offered since 2003 and are professionally accredited by the Planning Institute of Australia. The Diploma and Degree programmes are offered by the School of Geography and Environmental Studies in either full or part-time mode and are available in both on-campus and distance education modes. Since their introduction, an average of 44 students has enrolled annually. These include international students as well as students from a range of Australian jurisdictions including local students from Tasmania.

Tasmania is an island state of Australia and UTAS its only university. As a consequence the course is considered important in delivering planning education and building planning capacity within the state. An essential consideration for the development of the planning course was that delivery by distance mode had increased considerably since 2003, as shown in Figure 2.

The Master of Environmental Planning addresses the central role of environmental planning in achieving environmental, social and economic sustainability. Essential planning theory is integrated with understandings drawn from biophysical, social, cultural, legal and public policy disciplines. Urban, regional and rural environments are considered, and emphasis is given to planning across all land tenures at catchment and landscape scales. Extensive use of case studies and guest lecturers with practical experiences provide students with practical examples of major environmental planning issues. Students undertake an industry placement that provides opportunities to incorporate the knowledge gained in the course into planning practice. Masters students undertake a planning project or thesis in addition to their coursework (UTAS, 2012).

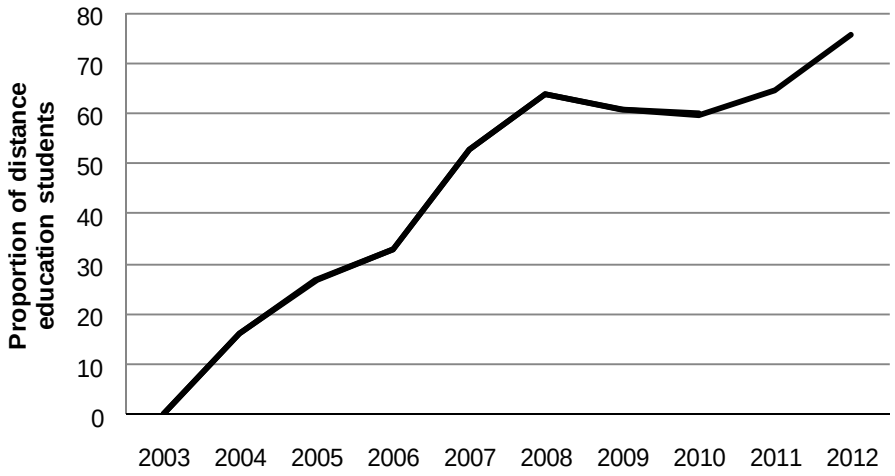

Figure 2 Increase in the proportion of enrolled distance education environmental planning students, 2003-2012, UTAS (Source: School of Geography & Environmental Studies, UTAS, 2012)

The process of review and development

The development of the climate change adaptation planning curriculum at UTAS was informed by an Expert Reference Group, whose members agreed that the coursework offerings needed to 'walk the talk' of adaptation so that students could be afforded the opportunity to rehearse the skills, competencies and attitudes they would need in their professional lives. This sense guided the teaching and learning approaches that were adopted. The curriculum package comprised:

- core modules containing knowledge about climate change relevant topics – climate science and scenarios, climate impacts, mitigation, adaptation, relationships between mitigation and adaptation, the relationships between sustainable development and climate change, and the implications of climate change for governance;

- a set of case-based content modules for urban, coastal, water management, biodiversity conservation, and bushfire planning and management contexts;
- practical exercises for adaptation planning competencies; and
- material on the pedagogies informing the curriculum.

Among the pedagogical guides supporting the teaching and learning philosophy behind the coursework are:

- problem-based learning (PBL) or learning through facilitated problem-solving (Hmelo-Silver, 2004);
- adaptive learning and self-reflection defined as any individual or social change of paradigms, world views or mental models that builds adaptive capacity;
- networked learning or learning in which information and communication technology is used to promote connections within a learning community (adapted from Jones, 2004); and
- linkage of theory and practice or enhancement of planning practice in rapidly changing conditions through being kept informed of emerging theoretical developments.

While the School's postgraduate courses are largely founded on PBL as a way of equipping students for professional practice, there had not been any conscious attention to this or the other three pedagogies for their value in building students' skills in planning for situations of complexity resulting from emergence and rapid change. In this respect, these pedagogies are more advanced than those used elsewhere in the School.

The learning environment established sought to foster critical, reflective and lateral thinking skills, foresighting and futures thinking, and an appreciation of systems thinking and complexity. Problem-and team-based exercises reinforced the relevance of cross-disciplinary investigation, collaborative and cooperative learning, networked learning, self-evaluation and reflection, and the linkage of theory to practice. These practical exercises afforded students with opportunities not only to experience team-based problem-solving but also to practice core adaptation planning competencies. Since this project, other Australian planning research has also acknowledged the relevance of these competencies, particularly the application of inter-disciplinary approaches, problem solving, and team work through a survey of planning employer needs (George *et al.,* 2010).

Subsequently, the materials were used as the basis for development of a standalone unit into which further core and content materials and practical skills exercises were incorporated. These additions helped position the unit to be attractive to students of both environmental management and environmental planning while development of the unit as a standalone unit enabled inclusion of more of the core competencies that planners may need in planning for climate change and its impacts. The unit was further augmented by the inclusion of a WIKI-based platform for case study delivery. WIKI, a software platform that allows users to create and edit Web content, has excellent applicability in support of interactive, problem-based learning especially for distance study mode.

Approaches to embedding climate change education in the University of Tasmania's planning course

Embed within existing coursework units or standalone?

While the most straight-forward approach to incorporating climate change educational materials into existing curriculum is to develop standalone coursework units, the risk is that climate change adaptation will be treated as an optional extra rather than being perceived as integral to all aspects of planning and management. Expert opinion stresses the importance of integrating materials into existing coursework rather than siloing them as separate units (Lyth *et al.,* 2007). The advantages and disadvantages of the two approaches are summarised in Table 1.

Table 1 Comparison of embedded and standalone approaches to integrating climate change adaptation into planning coursework

Embedded approach		Standalone approach	
Advantages	**Disadvantages**	**Advantages**	**Disadvantages**
• Climate change is more likely to be perceived as integral to all planning and management aspects	• May not achieve intended learning outcomes	• Students have time to make the most of the curriculum	• Potential for the importance of the curriculum to be downgraded and to be treated as an elective
	• Limitations on time available for discussion to unpack complexities of climate change	• More time available for discussion and interaction	
	• Important content may be omitted from host units to accommodate climate change content	• Ensures all relevant content can be included	
	• Requires flexibility in negotiating which new materials and practical exercises to include	• More flexibility in decisions about which materials/exercises to include	
	• Can compromise the objectives of PBL by retarding group co-evolution and dynamics	• Group-based work is more successful where group collaboration has continuity	

Option 1: Embedding within existing coursework units

There are two ways to overcome the risk of climate change adaptation being perceived as an elective. One method is to replace sub-components of existing coursework units with climate change modules and the other is to ensure that climate change is at least mentioned in existing planning coursework but with reference to a standalone unit, which would be mandatory. The approach that UTAS originally trialled in renovating its planning offerings was to deliver a core module containing a range of basic climate change related material to all students taking four 25% coursework units offered to postgraduate planning students as

part of a Master of Environmental Planning or Master of Environmental Management (column 1 of Table 2). A relevant content module (column 3 of Table 2) was also delivered to each of the four coursework units (column 2 of Table 2).

Table 2 Core module topics, coursework units, and content modules

Core module topics	Coursework units	Content modules
1. Climate change: science, impacts & scenarios 2. Systems approaches & climate change 3. Mitigation and adaptation relationships 4. Principles and concepts of adaptation 5. Climate change, sustainable development and governance	Planning, Theory, Process and Applications	Integrated coastal planning for climate change adaptation
	Planning for Sustainable Land Use Outcomes	Urban systems adapting to climate change
	Protected Area Management	Biodiversity, protected areas and climate change
	Sustainable Environmental Management	Incorporating climate change adaptation into water management

While it is logistically possible to incorporate modules or sub-modules into existing coursework units, there are a number of challenges to meet and trade offs to be considered. The UTAS trial experience suggests the amount of basic climate change adaptation material to which students need to be exposed may be too great for the ready integration of this core material into existing coursework.

One issue that might arise is whether the mainstreaming approach used in the trial results in important content being omitted in order to include the climate change content. The experience of the UTAS trial suggests that unit coordinators are generally willing to accommodate new materials and practical exercises they perceive would enhance existing coursework. Therefore, there has to be a degree of flexibility in the negotiations that determine which components and practical exercises are incorporated. For example, vulnerability indicators were selected for the vulnerability assessment exercise in the integrated coastal planning module (see Table 2), in part because the unit coordinator was keen for students to gain experience in the use and development of planning and assessment indicators.

Another issue is that incorporating climate change modules into an existing programme can also have an effect on problem-based learning founded on small group work because of impacts on the co-evolution and dynamics of groups. Although it was not possible to definitively confirm these claims during the trial, informal observation suggests that group-based work is more successful where group members' collaborations have some continuity. Group coherence and properly functioning group dynamics take time to develop.

Option 2: Development of a standalone unit

From the perspective of group dynamics, a standalone unit may be preferable in order to achieve the benefits that ongoing collaboration and co-evolution bring to group dynamics and adaptive learning – that is, the need for the group to behave as a complex adaptive system (Mennin, 2007). For this the members have to develop an appreciation of their interdependence and have a high level of interaction and trust. These qualities provide the

basis for the discussion, exchange of ideas, dialogue, debate and sharing of information that lead to new collective and individual understandings, new insights, creativity, and possibilities for change (or self-organisation, in resilience language). According to complexity theory, a group that is creative is said to be working at the edge of chaos or in the zone of complexity (Stacey, 2002), the zone where learning occurs (Mennin, 2007).

A standalone unit may also be preferable from the perspective of doing the materials justice and ensuring that students are able to make the most of the curriculum. To achieve the same outcomes using the integrated approach would require innovative and flexible coursework structures.

In sum, while the benefits of mainstreaming may be theoretically attractive and logistically possible, on balance, for broader aspirations to be satisfied, a standalone unit may be preferable. However, to avoid the unit being interpreted as an elective, it must either be mandatory or at the very least cross-referenced with other units in a programme.

Pedagogies for climate change education

Pedagogy (the correct use of instructive strategies) was taken seriously in the design and development of the course unit in recognition that teaching for and about climate change adaptation is not just about imparting knowledge about theory and best practice but is also about the development of practical competencies, as well as the encouragement of essential learning attitudes and capabilities, such as adaptive learning and networked learning. The capacity for such learning attitudes is particularly relevant to climate change adaptation where there is changing and uncertain information, and complex problems to manage.

The following summarises a sample of pedagogies that were seen to be particularly relevant to education for climate change adaptation and demonstrates how they were applied.

Problem-based learning

Problem-based learning was the pedagogical foundation for the UTAS climate change adaptation coursework materials and in turn facilitated the application of other important pedagogical strategies, especially networked learning and adaptive learning. PBL is a learner-centred approach to instruction that uses problem-solving as the starting point for learning and for development of problem-solving and team skills (Bligh, 1995). Learning occurs in small groups with teachers as facilitators and new information is acquired by self-directed learning (Barrows, 1984, 1996). Thus, PBL ‘empowers learners to conduct research, integrate theory and practice, and apply knowledge and skills to develop a viable solution’ to real-world problems (Savery, 2006, p.9). In this paper we focus on PBL as involving student-centred, team-focused learning activities that are concentrated around specific problems associated with planning for climate change.

Relevance to education for climate change adaptation

As Savin-Baden (2000) points out, the objectives of PBL can be varied as defined in the following five different models: (i) attainment of knowledge; (ii) PBL for professional work; (iii) PBL for interdisciplinary comprehension; (iv) PBL for cross-discipline learning; and (v) PBL for critical competence. In the case of education for climate change planning, we argue that

all these models and learning intentions are relevant and important. Because of its focus on group-based problem-solving, PBL provides an appropriate format for learning and skills development relevant to complex problems. In addition, the goals of PBL of helping students to develop flexible knowledge, effective problem-solving skills, self-directed learning skills, effective collaboration skills, and intrinsic motivation, make it extremely attractive.

More specifically, as climate change is at the intersection of a range of physical and social sciences, there is a requirement for a learning environment that is compatible with interdisciplinary investigation. Secondly, PBL requires students to apply critical reflective thinking abilities thereby helping to prepare them to deal with high levels of uncertainty and complexity.

Thirdly, PBL encourages students to become active participants in their own learning which is an important quality in the climate change area where no student can be expected to learn all they need to know in the class-room and where knowledge about climate change science and problems is still evolving. This active learning approach has been shown to increase student interest and motivation and to build students' critical thinking, problem solving and social skills (Hanson and Moser, 2003).

Lastly, PBL relies on a culture of collaboration and cooperation, which is particularly suitable for students entering the climate change field where the breadth and complexity of the subject matter necessitates contributions from a wide variety of perspectives and disciplines. Reliance on collaboration constitutes recognition that no one person or organisation has the resources to address the complexities of wicked problems.

How we facilitated problem-based learning

In PBL, the problem is the starting-point of the learning process. Usually problems are based on real-life problems or scenarios selected to meet educational objectives and criteria, although they can also be hypothetical problems (especially important where there are few examples of good practice, or where problems are only emerging or in early evolution). As explained by de Graaf and Kolmos (2003), it is crucial that the problem is the basis for the learning process, because this determines the direction of the learning process and places emphasis on the formulation of a question rather than on the answer. This also allows the learning content to be related to the context, which promotes student motivation and comprehension.

All group-based work was underpinned by the principles of PBL. Group-based activities and assessment tasks were designed to allow students opportunities to 'try', 'rehearse' and 'develop' a range of educational skills and capacities relevant to climate change adaptation planning and management. Integrated into the approach was the opportunity for students to practice real planning techniques (such as a charrette process, risk assessment, vulnerability assessment, and scenario development), as well as considering a variety of stakeholder positions including via the application of role play. Some of the PBL learning activities and assessment tasks are summarised in Table 3.

Table 3 Problem-based learning activities and assessment tasks

Problem	Activity and Assessment task	Skills/capacities development
1. A Tasmanian municipality with perceived vulnerabilities to sea-level rise and associated climate change impacts. How to assess current vulnerability and track future vulnerability to sea level rise and coastal storm events?	*Vulnerability assessment:* Group A: Undertake a vulnerability assessment by developing a set of current vulnerability indicators. Group B: Prepare a set of future vulnerability indicators using a range of data – risk assessments, and social, demographic and economic studies.	• Reinforced the relevance of interdisciplinary investigation, collaborative and cooperative learning, and self-evaluation. • Gave students practice at indicator development and elements of vulnerability assessment.
2. A hypothetical proposal for a tourist and holiday development on a rural property located near the entrance to an estuary to demonstrate the complexities of integrated coastal planning. There was a range of social, economic, environmental and climate change issues to be considered (sea-level rise, storm surge, protection of endangered species, international agreements for the protection of migratory birds, low rainfall and unreliable water supply, the importance of an aquaculture industry to the local economy, potential water quality impacts).	*Role play:* The exercise required students to take on various roles in making submissions to a state planning authority and then to take up roles in either of two policy advisory committees. They were tasked to: (i) Consider the lessons for Integrated Coastal Planning emerging from stakeholder representations and associated discussions. (ii) Formulate recommendations on integrating climate change into coastal planning.	Students: • Considered and integrated a range of relevant planning and environmental management legislation. • Adopted an interdisciplinary approach and explored complexities of integrated planning. • Undertook critical evaluation of submissions. • Collaborated via group-based work and undertook networked learning. • Role play enhanced students' skills in argument, advocacy, communication, and negotiation.
3. Developing skills to deal with the high level of uncertainty associated with climate change and assist foresighting.	*Scenario development:* Group A: Generate scenarios relating to climate change impacts on the Australian Snowy Mountains alpine ecosystems. Group B: Develop scenarios relating to climate change impacts on Great Barrier Reef coral reef ecosystems. Both groups were asked to discuss and prepare a set of leading indicators to monitor the unfolding of scenarios and suggest appropriate planning or management responses.	• Exposed importance of strategic planning. • Practiced scenario development which enables planners to envision a range of plausible futures and together with indicators to monitor the unfolding of scenarios. • Provided exposure to monitoring methods which are essential to support adaptive learning and adaptive planning.
4. Securing water supplies for a drought-prone city in southern Australia with the aim of making the city resilient to climate change and climate variability.	*Charrette:* Groups undertook a charrette exercise to develop competing consultant tenders for the coordination, implementation, and evaluation of an integrated adaptive water management strategy for the city. Consultants were required to present their concept plan to a panel of expert judges.	• Experience in collaborative and interdisciplinary approaches. • Recognised diversity in student expertise, skills and knowledge. • Linked theory to practice - application of integrated and adaptive management approaches to a real-life problem. • Critical analysis and self evaluation of individual contributions and the groups' approaches supported adaptive learning. • Topic complexity and organisational demands of the exercise obliged groups to network and work collaboratively.

Adaptive learning and self-reflection

The PBL approach also helped to develop qualities which are important for the development of adaptive learning capabilities. Adaptive learning is defined variously as learning to cope with and modify stressful situations (Rohrkemper and Corno, 1988); any improvement or development of paradigms, world-views, or mental models (Chiva *et al.,* 2010); or learning that builds adaptive capacity for increasing the resilience of social-ecological systems (Davidson-Hunt and Berkes, 2003). Adaptive learning is essential for complex adaptive systems to adapt to changes in the environment without endangering their essential structure and function (Chiva *et al.,* 2010; Krasny and Tidball, 2009).

Under conditions of rapid and enduring change in complex adaptive systems, planners must engage the principle critical self-reflection to be able to examine emergent situations and to reflect upon and interpret the data gathered about them. Critical thinking combined with self-reflection therefore becomes essential to successful adaptation (Emison, 2010). Critical self-reflection has also been identified as a component of triple loop learning that occurs when collectives reassess norms, institutions and paradigms as a prelude to undertaking governance change (Folke *et al.*, 2009).

Relevance of adaptive learning to education for climate change adaptation

Adaptive learning is needed for planned adaptation because it involves processes of experimentation, self-reflection and self-evaluation that lead to improvements on previous actions. Therefore it was felt that practice in these skills, which are useful throughout a professional lifetime, was important in this coursework.

There is also a need to recognise that while many problems may be similar in a broad context, diversity between places (whether by differences in governance or planning frameworks, stakeholder positions and values, financial resources, or the availability of informative data) requires a capability to adapt previous knowledge, experiences and approaches accordingly. Consequently, planning for climate change requires adaptive flexibility and an appreciation of the evolutionary nature of the places that are being planned and managed. In turn, this necessitates a continuous process of adaptive learning informing planning competencies, such as: ways of understanding problems; collecting, interpreting and conveying information; and developing, trying and evaluating response options.

As Rammel (2003) explains, adaptive, process-based learning is supportive of flexible policy responses that will be required in an environment of dynamically evolving situations, and to deal with the inevitable surprises of the interactions of complex social-ecological systems.

How we facilitated adaptive learning

The course unit incorporated the opportunity for students to develop adaptive learning attitudes through the establishment of case studies and practical problem-based learning activities which framed climate change adaptation problems in the above context. More traditional instruction on the theoretical concepts around adaptation, adaptation planning and adaptive environmental management also served to underpin both the understanding of adaptive principles and the critical assessment of their application.

Probably the most hands-on facilitation of adaptive learning, however, occurred through the WIKI assessment project, which centred on a case study of planning and managing for increased fire risk in peri-urban bushland areas (Stack and Davidson, 2011). This case study was offered in the second iteration of the coursework as a standalone unit. The WIKI project was initially spread over three weeks (but subsequently extended to six weeks to allow for adequate reflective thinking and networking) and involved creation of a multi-media interactive online learning environment, the key elements of which included:

- a challenge for student groups to develop a framework for a planning or management strategy, that would help to build social-ecological resilience to bushfire in peri-urban bushland localities;
- the case study which involved a comprehensive 'environmental scoping' of a suburb of Hobart (Tasmania) that had a history of bushfire risk, with interviews of stakeholders as well as documentation;
- resources based on eight key perspectives relevant to bushfire management, students being required to become 'expert' in two of these perspectives;
- a structured approach for teams to investigate the case study including individual team online workspaces;
- a navigation guide which included an introduction to the WIKI, how to navigate it, and indications of the types of thinking and group processes required; and
- opportunities to discuss and ask questions with two industry stakeholders in a forum.

One key objective of the task was to have students challenge the assumptions underpinning existing approaches to bushfire management and planning and to contemplate different ways of thinking and operating that might be suggested by applying adaptive management and resilience lenses to strategy development.

To scaffold students through the task, it was broken into four sequential sections. In section 1, student teams were asked to analyse critically existing planning and management strategies from their chosen expert perspectives and to identify the key issues emerging from their analysis. In section 2, building on this knowledge, they identified potential criteria for their strategy, these being criteria that others could use to assess strategic plans in other peri-urban communities. In section 3, they conducted a gap analysis to determine the gaps in existing strategies. Based on the accumulated learning from the first three sections, in section 4, groups were asked to scope out a detailed framework for a planning or management strategy, including justification of its components and their likely content.

Each group had its own working page with suggestions as to how to manage the task and how to structure each section. The group pages were designed so that students could add or edit content and engage in discussion. They could also add further content from their own research to help build the resource pages. Students had a number of opportunities to reflect on their learning and adapt to new understandings: (i) at strategic points, the task designers asked questions about students' experiences of specific tasks; (ii) students were invited to reflect on why they thought their selected criteria were important; and (iii) they were asked to comment on the relevance of their strategy components to adaptive management and resilience. Students were also given the opportunity to evaluate the task on its completion.

Networked learning

Networked learning offers a meaningful response to the most complex challenges of our time. Human interaction, whether synchronously or asynchronously, is central to networked learning while there is a strong consensus about the value to learning of cooperation, collaboration, dialogue and community (Goodyear *et al.,* 2004). The University of Lancaster's Centre for Studies in Advanced Learning Technology (2001) points to the enhanced possibilities for networked learning through the application of communication and information technology (C&IT) which can serve to promote connections among learners; between learners and tutors; and between a learning community and its learning resources.

Relevance of networked learning to education for climate change adaptation

Networks are self-organising structures, which operate on the border of chaos and order (in Stacey's (2002) zone of complexity referred to earlier) and the zone where learning occurs. They also provide an interdisciplinary framework for understanding a wide variety of phenomena (Jones, 2004). Networked learning is therefore an essential skill for planners dealing with complex challenges.

Networked learning presents a promising technology for supporting participative and collaborative approaches to learning (Hodgson and Reynolds, 2005) and it is important in developing learner autonomy and the skills for life-long learning (Zenios *et al*., 2004). The dialogue component of networked learning is useful in helping practitioners to recognise, critique and move beyond their taken-for-granted assumptions about the world, and about their professional practice and learning (Goodyear *et al*., 2004). These aspects of networked learning are all relevant in coping with messy and complex problems such as planning for low carbon settlements where consideration needs to be given to energy supplies, transport modes, building design and placement, local food production or greening the urban environment.

Students need practice at networked learning so that they can develop and maintain connections with people and information and so support one another's learning. This ability is critical in the context of rapid change and uncertainty about the future and where understanding about specific problems around climate change is emergent. In addition, planners will need mutual support to take risks associated with adaptive learning and management. Supportive and informative networks of people and information (communities of practice) will become increasingly important for this purpose.

How we facilitated networked learning

The UTAS course unit applies opportunities for networked learning via C&IT in addition to more traditional face-to-face opportunities to engage in workshop activities and team based assignments. The course unit was able to assist development of networked learning through the application of on-line learning tools where information resources were posted and links to other information, networks and practical case studies were provided. Opportunities to work together in teams to develop networked learning skills were also offered through use of the WIKI tool mentioned in the previous section. The WIKI facilitated networked learning by

providing an online platform for interactions among team members and between lecturers and students.

Linkage of theory and practice

Among the objectives of the UTAS course was the aim to provide students with opportunities to apply their new conceptual understandings to planning practice through the skills development elements of the course. It was also intended that practice at these skills would develop in students a greater understanding of the key concepts and theoretical approaches underpinning the course.

Relevance of linking theory to practice in education for climate change adaptation

Linking theory to practice in professional development coursework has been shown to be advantageous for students (Smith *et al.,* 2007). However, in the context of equipping planners to cope with wicked problems, it becomes an essential educational element. Because climate change is beset by complexity, many uncertainties about outcomes, and many of its more consequential impacts are predicted to be felt in the longer-term, planning practitioners need to be able to apply new conceptual perspectives to planning tasks as they evolve. They therefore need to have the skills to learn about new knowledge and information in an ongoing fashion. In addressing complex problems, planners will need to practice their craft as practitioner-researchers. Planning practice will be informed by applying high level (as well as everyday) thinking to the novel challenges confronting them, supported by a level of reflection and critique to promote learning.

How we facilitated linkage of theory to practice

The coursework is underpinned by a combination of experiential and enquiry-based learning with the links between conceptual content (complex adaptive systems, resilience thinking, and adaptation theory) and planning practice being made in several ways and facilitated by problem-based learning approaches:

1. Generally, where prior to each of the practical exercises, students are introduced to their practical and theoretical origins and their importance as components of developing adaptation strategies;
2. For specific skills, where, for example, the need for long-term planning is captured in the opportunity to prepare a planning strategy in the bushfire case study exercise mentioned above, in practice at visioning techniques (i.e. scenario development through a backcasting technique) and insights from resilience theory and the adaptive management concept are secured through practice at monitoring methods (i.e. indicators to monitor current and future coastal risks) and through the use of collaborative, group-based techniques; and
3. To build the self-reflection capacities that will enable them to apply novel concepts to planning practice, students are asked to consciously make the links between theory and practice as in the previously mentioned case study of bushfire planning and management, where they are invited to explain how they are applying the theory of adaptive management and resilience in developing a strategic planning or management framework.

Lessons for Planning Education

As planners have to deal with an array of challenges at any given time, the emergence of a new challenge, such as climate change adaptation, on the planning agenda and the adaptive learning that planners are required to undertake to build their capacity to respond, is not a particularly new phenomenon for the planning community (Lyth, 2006). Although, because of the uncertainties associated with climate change impacts at the regional and local scale and the likely multifaceted implications for places and society (some of these insidious and hidden), the climate adaptation challenge is especially difficult and may be particularly daunting for these reasons. This does not mean that it is particularly difficult to build the capacity of planners to face climate change adaptation problems in a commendable way. As has been demonstrated in this paper many of the practice skills, planning tools and learning competencies tried and developed through the UTAS course unit are just as relevant to other difficult if not 'wicked' challenges facing regions, cities and communities in the immediate to medium term (presented conceptually in Figure 1).

In fact most of the approaches and tools have been developed through other planning problems or tried in other disciplines. In this regard, we found that the development of the course unit and students' evaluative feedback on the group-based practical skills component reinforced the value of various planning approaches, tools and skills and as a consequence reinforced the importance of planning, particularly strategic and integrated planning. For example, the development of skills in undertaking vulnerability assessment is useful in a range of contexts including planning for an escalation in transport fuel costs (whether due to peak oil or other forces), while systems thinking is an important approach to understanding a range of problems that have interrelated components and facilitates necessary analytical and critical thought by planners. Similarly, development of understanding about sustainable urban and landscape design is relevant not only to planning for a future under climate change, but also to facilitating low carbon societies, communities less dependent on car use, and planning for the needs of an increasingly aged population. The importance of effective planning communication will become increasingly relevant in facilitating understanding about the need to adapt or transition to new ways of doing, living or decision making; while integrated impact assessment and integrated strategic planning that appropriately guides operational planning, statutory planning and decision making processes will remain essential for responding successfully and comprehensively to the many integrated and interwoven planning problems we currently face.

In addition to this, reinforcement of the value of various planning approaches, tools and skills is the value of education for climate change adaptation itself in building stronger capacity within the planning community generally to do 'good' planning and strengthen fundamental competencies in graduate planners. By incorporating education for climate change adaptation into the core of planning programmes, planning students are likely to be engaged in some of the most difficult contemporary planning problems. Moreover, if the pedagogy facilitates their hands-on involvement in problem solving and develops their capacity in, and appreciation of, adaptive and networked learning in addition to more traditional planning

education, such as building theoretical foundations and linking these to practice, then planning education should serve future planners well.

The UTAS experiences described in embedding education for and about climate change adaptation into the planning course have assisted reflection on, and careful thinking about, relevant pedagogies, their application and wider relevance to a range of other complex contemporary and emerging planning issues. The standalone climate change adaptation planning unit is approaching its time for review and update in order to maintain its relevance. Evaluation of the usefulness and effectiveness of the unit in terms of developing specialised and generic planning capabilities for responding to complex problems is intended.

Acknowledgements

The authors wish to thank: the funders of this project, the Australian Greenhouse Office (now the Department of Climate Change and Energy Efficiency) Climate Change Adaptation Skills for Professionals Programme; members of the project's Expert Reference Group, Michael Lockwood, Aidan Davison, Anna Lyth, Kristin Warr, Rosemary Sandford, Gerry Kregor, Elaine Stratford and Neil Holbrook; and the two anonymous reviewers who provided valuable suggestions for improvements of this paper.

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