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Embedding climate change in the curriculum

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Embedding Climate Change in The Curriculum
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Abstract
Climate change presents significant scientific, technical, ethical and political challenges. Attitudes to climate change are a function of tradition and culture, and the prevailing discourses in society and the media. Educators have a key role in understanding these attitudes and promoting behavioural changes. However, the transdisciplinary nature of the issues can present a problem for staff and students alike. While it is relevant to many, or most, areas of the curriculum, traditional discipline and organisational boundaries, and the knowledge, skills and educational history of both staff and students, can prevent engagement. Examples include teaching the concepts in non-science courses, engaging science disciplines with the political and ethical issues, and developing the understanding of responsibility and its relevance in vocational, business-related courses.

In this paper I describe a review of courses across a higher education institution to understand how climate change is incorporated into the curriculum, and the development of teaching and materials for use across disciplines. Examples and discussion will be contextualised to China and its role and position in global climate change issues.

Introduction
Climate change is the greatest environmental challenge facing the world today. To meet this challenge, the world needs minds capable of creating new possibilities for meeting our basic needs such as energy, water, shelter and food; minds that can transform our daily experiences into ones that allow a sustainable development, safeguarding our opportunities and the environment for future generations.

The higher education sector is where these minds are trained and developed. Therefore, it is crucial that the sector contributes strongly to sustainable development. It can do so by training and expanding these young minds; researching answers to challenges and informing public policy; showing its own understanding and commitment through careful campus management; and by being a responsible employer and active member of the business and local community. Professor Lord Stern of Brentford, Foreword in HEFCE (2009)

These words illustrate the growing concern at policy level in the UK of the impacts of climate change, and the role of universities, both as organisations and teaching institutions, in responding to the threats. The role identified for universities here, way beyond that of researching the problems, poses a significant challenge to our understanding of higher education – what it is for, how it operates, and how curricula can be developed across the different disciplines which encompass the range of issues implicit in the statement. I shall show there are difficulties and tensions, but significant opportunities to respond to the challenge which can no longer be avoided.

Role of Higher Education
Views on the purpose and role of higher education vary across the world (Gough & Scott 2007), but the discourse and policy in the UK has been largely shaped in recent years by what

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has become known as the Dearing Report (Dearing 1997). In this, four main purposes are identified:

- *to inspire and enable individuals to develop their capabilities to the highest potential levels throughout life, so that they grow intellectually, are well equipped for work, can contribute effectively to society and achieve personal fulfilment;*
- *to increase knowledge and understanding for their own sake and to foster their application to the benefit of the economy and society;*
- *to serve the needs of an adaptable, sustainable, knowledge-based economy at local, regional and national levels;*
- *to play a major role in shaping a democratic, civilised, inclusive society.*
(Dearing 1997, Chapter 5)

These ideas have recently been explored and expanded in the context of sustainable development by Gough & Scott (2007). These authors discuss the tensions between the roles of higher education producing the skills base to serve society and the economy, and its contribution to personal development and the intellectual and moral improvement of the human condition - the so-called "real world" or "ivory tower" views. Added to contested notions of how sustainable development is actually defined, these tensions have perhaps held back the incorporation of sustainability principles within higher education.

Ward (2007a, b) has critiqued the role of higher education in the UK and its (lack of) engagement with climate change problems. He sees the fundamental problem being due to the influence of capitalism and consumerism, mediated through government policy, on education generally, and on universities in particular. He argues that universities may be compromised by their pursuit of research funding, including that of major corporations and the petroleum and energy industries. With particular reference to the curriculum, he concludes:

Our current education system at all levels, with its discrete, economically justified curricula, designed for the knowledge based economy, lacks any element for holistic approaches to global problems such as environmental degradation (Ward 2007b, p.15).

Contribution of Higher Education to Climate Change
In the UK, the Climate Change Act (2008) established a legally binding target of at least an 80% cut in greenhouse gas emissions by 2050, and a reduction in CO_2 emissions of at least 26% by 2020, both targets against a 1990 baseline. This imposes a Carbon Reduction Commitment (CRC) (Defra 2009) on large organisations which consume more than 6,000 MWh of energy per year. This includes many universities. At present this only includes energy consumed on site, but in future is likely to incorporate emissions related to travel and waste. The CRC is a cap and trade system, so organisations purchase carbon credits, with a price currently set at £12 per tonne of CO_2 for the first year of the scheme (2010 – 2011). Companies receive a rebate the following year, based on the cost of the credits ± 10% in the first year, with this rising to ± 50% in the fifth year. The variation is based on the company's position in a league table of environmental performance. Initially this will be determined by actions such as the number of sub-meters installed and certification to the Carbon Trust Standard[2], but will eventually be judged mainly on emissions reductions. So there are now strong financial incentives and penalties for universities to address their carbon emissions, and any actions will need engagement with staff and students.

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[2] See www.carbontruststandard.co.uk/

This wider legislative framework also informs the policy of the Higher Education Funding Council for England (HEFCE) and its counterparts in Scotland, Wales and Northern Ireland. HEFCE distributes core funding for students, learning, teaching and research, and provides capital funding for universities. Earlier policies and actions of HEFCE (e.g. HEFCE 2005) were criticised by Ward (2007a) for failing to address climate change at all, despite the rhetoric around sustainability. However, its more recent publications are now more explicit. The policy on sustainable development in higher education (HEFCE 2009) notes that English universities have energy bills totalling £250 million a year, resulting in around 1.6 million tonnes of CO_2 emissions. The same report also notes (p.18) that the sector spends over £8 billion per year in non-pay costs, so how and where that money is spent can have a significant social and environmental impact. Although there is wide variation across institutions in their consumption of resources and emissions, there does seem to be some evidence of improvement (Table 1).

Table 1 Energy and water consumption and waste indicators for English HEIs, 2006-07 (source, HEFCE 2009)

	Lower quartile	Median	Upper quartile
Energy consumption per student FTE*	2,288 kWh	3,201 kWh	6,449 kWh
Percentage change 2004-05 to 2006-07	*-7%*	*-7%*	*-11%*
Water consumption per student FTE*	7.6 m^3	11.5 m^3	25.0 m^3
Percentage change 2004-05 to 2006-07	*4%*	*1%*	*2%*
CO_2 emissions per student FTE*	643 kg	863 kg	1,593 kg
Percentage change 2004-05 to 2006-07	*-4%*	*-12%*	*-15%*

* FTE: full-time equivalent

While the precise details of calculations are not explicit in either publication, these figures for UK universities would appear to be lower than for many in the USA. In a sample of 13 institutions, Rappaport & Creighton (2007, Table 2.2, p.24) record per capita emissions of between 360 – 9950 kg CO_2. For an individual institution, Rappaport & Creighton (2007) provide a detailed case study of approaches to reduce the climate change impact of Tufts University in the USA which could be used as a template for other institutions. It is interesting to note in their analysis that the wealthiest universities (as measured by their endowment funds) tend to have the greatest per capita emissions (Chapter 2, p.22), mirroring the relationship between wealth and emissions of countries. They suggest that less well-off institutions may have been quicker to embrace routine energy saving measures than their wealthier counterparts.

A voluntary scheme exists in the USA for universities and colleges to monitor and report actions to combat climate change. Recent data are summarised in Table 2. While recognising that the sector in the USA is larger, more diverse and does not have the centralised policy and control of that in the UK, it is nevertheless disappointing to see that as many as 20 – 30% (of those who reported) do not even have policies to reduce energy consumption through more efficient buildings or purchasing – two areas that would seem to make economic sense even if responsible development was not the key driver.

Table 2. Measures to reduce greenhouse gas emissions at some universities and colleges in the USA. Data accessed from http://acupcc.aashe.org/statistics-tangible.php on 5 June 2009.

Action	Schools Committed (Total = 514)
1. Establish a policy that all new campus construction will be built to at least the U.S. Green Building Council's LEED Silver standard or equivalent.	368 (72%)
2. Adopt an energy-efficient appliance purchasing policy requiring purchase of ENERGY STAR certified products in all areas for which such ratings exist.	412 (80%)
3. Establish a policy of offsetting all greenhouse gas emissions generated by air travel paid for by our institution.	46 (9%)
4. Encourage use of and provide access to public transportation for all faculty, staff, students and visitors at our institution.	323 (63%)
5. Within one year of signing this document, begin purchasing or producing at least 15% of our institution's electricity consumption from renewable sources.	181 (35%)
6. Establish a policy or a committee that supports climate and sustainability shareholder proposals at companies where our institution's endowment is invested.	45 (9%)
7. Participate in the Waste Minimization component of the national RecycleMania competition, and adopt 3 or more associated measures to reduce waste.	297 (58%)

It is perhaps not surprising to see that air travel and investment policies are the least well developed, as the former would be an additional cost, even if travel were restricted (which would itself raise questions about how the institution operates), and the latter would raise fears that the institution might see lower returns on investments. Both of these measures which carry immediate cost implications may be further affected because as has been widely reported, for example in The New York Times (2009), the value of university endowments has fallen significantly since the onset of the current global financial crisis. The actions of UK universities are being discussed in June 2009 at a roundtable debate organised by Times Higher Education and the Carbon Trust entitled 'UK HEIs are home to some of the world's experts on climate change and sustainability but are they putting their own house in order?'. We shall see.

Education for Sustainable Development (ESD)

Climate change could be considered as a topic under the broader heading of education for sustainable development. There is a considerable literature on this, from compulsory school-age education through to universities. A consistent theme is that sustainable development education, as distinct from environmental education, is highly complex and interdisciplinary, and consequently requires the development of high level skills in both teachers and students (e.g. Dale & Newman 2005). This has had implications for its incorporation into school

educational programmes across the world, for example in Australia (Tilbury 2004) and the USA (Fortner 2001). Some authors have argued that the school education system actively mitigates against incorporating such a subject which is holistic, co-operative and interdisciplinary (Stevenson 2007). Comparable concerns exist in higher education, with staff largely supportive of its inclusion in the curriculum, but voicing concerns about the complexity, fit with subject areas, and how it could be taught (Cotton et al 2007), although there are examples of highly creative ways of engaging students, albeit those on a geography programme who might be expected to be motivated, skilled and engaged with the issue (Rebich & Gautier 2005). Nevertheless, policy drivers, in the UK at least as evidenced in my introduction, are pointing towards its inclusion across the curriculum, perhaps catching up with those who have been advocating it for some time:

What is particularly missing is the study of global warming in the curricula. It should, without doubt, be present across almost the entire spectrum of university teaching. No other educational opportunity like this presents itself. Before these students depart to their careers in whichever field they have chosen, it is fundamental that they realise what that role that field plays in humankind's contribution towards the changing of the planet's climate. Ward (2007a, p.178).

Case Study: Leeds Metropolitan University
Leeds Metropolitan University arose through the amalgamation of several smaller specialist colleges during the 20th century. It became Leeds Polytechnic in 1970, and Leeds Metropolitan University in 1992, and currently has around 52,000 students. Buildings are divided between the city centre and a campus approximately 5 km away. The city buildings were mainly 1960s tower blocks, which are gradually being replaced by modern, more energy-efficient units. The separate campus largely comprises older, listed buildings; that is they are protected by law because of their historical and architectural significance. The nature of the estate, and the fact that having two separate campuses means significant inter-campus travel, poses significant challenges to sustainability strategies. Nevertheless, in 2003, it became the first university in England to achieve the ISO 14001 international standard for environmental management. In 2008 it ranked in the top 50 Sunday Times Best Green Companies League, being the highest placed university. Contributory factors included the fact that 85% of energy comes from renewable sources, the university employs full-time environmental co-ordinators and regularly consults and informs staff on green issues, and there are travel, recycling & purchasing policies in place. The University has also been awarded Fairtrade status.

The project on 'Embedding Climate Change in the Curriculum' was conceived in late 2007 in response to the feeling that there was no knowledge of the extent to which climate change and related issues of sustainability were addressed in teaching and learning across the institution, and since they cut across the curriculum a university perspective was necessary. Our impression from colleagues was that climate change (and related issues) was not always incorporated into the curriculum where it could be, and colleagues may have been working in isolation or duplicating effort. As the subject is so wide-ranging and interdisciplinary, and requires both technical knowledge and high level skills in systems analysis (Dale & Newman 2005) we were concerned that individuals working in relative isolation would not be dealing with the subject in a holistic manner (if at all). With no obvious focus for broad climate change research and teaching within the institution (i.e. no earth or environmental sciences) our goal was to create a network of individuals across faculties and disciplines to help embed this subject across the curriculum, share the expertise and good practice of staff, develop shared teaching materials and enhance the student learning experience as a result. Given that

the university has been recognised as having taken a lead on environmental issues, it was also fundamental to the project that the Sustainability Manager and team were involved. Case study materials will have immediate relevance to students, and will illustrate the framework within which the university operates, and tensions between some of its areas of operation. Being so close to home we predict that this kind of case study is likely to have a greater impact in changing student behaviour (e.g. switching off electrical appliances) or expectations.

Thinking of the nature of the institution and subjects taught within it, these were some of our *a priori* ideas of how climate change could relate to curricular areas:

- Politics, social sciences – political and social policy
- Business, economics, law – corporate social responsibility; consumer behaviour; costs of mitigation and adaptation; economic models of development and growth; notions of discount rates; legislation to reduce emissions
- Ethics and development – spatial and temporal components of responsibility and justice; water resources; population movements; millennium development goals
- Tourism, hospitality, events – impact the industries have, e.g. carbon emissions of flights, and the consequences of climate change for destinations and related businesses; responsible tourism, event and hospitality management
- Health – changing patterns of disease and vectors; mortality from heat stress
- Built environment, architecture & landscape design – energy efficient buildings; planning issues; urban design; consequences for the landscape
- Arts – cultural consequences; artists' responses
- Education – education for sustainable development agenda; curriculum & pedagogy
- IT/Computing – resource use, recycling, green computing, role of ICT in sustainable development and lowering emissions

The survey of actual practice gave the overall impression that although there were some centres of activity and good practice, and many staff were interested at a personal level, there was no evidence of broader inclusion across the curriculum, even in areas where it might be expected. It is not my intention here to highlight the gaps, but to briefly illustrate some activities across diverse areas.

Two research and teaching centres have climate change issues explicitly at their core. The Centre for the Built Environment[3] works on emissions and energy efficient buildings, and produces a range of teaching materials, including online and virtual simulations. The International Centre for Responsible Tourism[4] works extensively on areas of pro-poor tourism, sustainability, conservation and protected areas, with Masters courses for professionals in the sector. Elsewhere, recent curriculum developments have included an MSc Green Computing[5] which identifies that 'green' issues are a major concern in terms of their business, social and environmental impact in the 21st century. With the almost universal adoption of ICT, this industry has a significant carbon footprint and students investigate green ICT technologies, assess the environmental impact of ICT and look at how companies can streamline their systems, increase sustainability and save energy costs.

Sector-specific reports and initiatives on climate change can influence curriculum content within highly vocational degrees. The course team of the BSc Entertainment

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[3] See www.leedsmet.ac.uk/as/cebe/build.htm
[4] See www.icrtourism.org/
[5] See www.leedsmet.ac.uk/inn/courses_msc_green_computing.htm

Management have developed a new module on Responsible Entertainment, and updated the curriculum within a module entitled Contemporary Issues, partly in response to a report on carbon emissions by the London theatre industry. This is currently estimated at 50,000 tonnes CO_2 per year, with an additional 35,000 tonnes due to audience travel, and strategies are suggested for reducing them (Greater London Authority 2008). Such a clear drive from the sector for more sustainable practice is clearly a strong driver for the incorporation of materials on climate change, emissions and sustainability into the curricula of degree schemes for which it might, on the face of it, appear to have little relevance. This notion of tailoring information to make it directly relevant to peoples' concerns (in this case their chosen profession) is one of the suggestions for breaking down barriers to engagement suggested by Lorenzoni et al (2007).

Other opportunities for engaging with the sustainability agenda in courses that have not traditionally been involved can come through shared teaching sessions. In one example, students on the MA Peace and Development course were taught together with those on the BA Managing International Hospitality. Though a simplistic exaggeration, these courses could be considered to be in different places along the spectrum of vocational and academic courses, or the 'real world' and 'ivory tower' dichotomy of Gough and Scott (2007). Together they studied a module entitled 'Working as a Global Citizen', which covers ideas of responsibility and ethics in the workplace, including sustainability and climate change. The dynamics of two groups of students who would not normally interact (indeed, would normally be on different campuses) allowed the development of understanding of others' positions; education where learners are challenged by the experiences and perceptions of others, rather than direct personal experience (Gough & Scott 2007, Chapter 15).

These few examples illustrate pockets of activity and expertise across a wide range of disciplines and faculties, and that given individual and institutional will to develop and share resources, the lack of an obvious centre is no barrier to climate change being incorporated across different curriculum areas. Our next challenge is to roll out materials for wider use.

Tensions Within Academia
I am not suggesting it will be straightforward to embed climate change and sustainability across a university's operations. There are a number of structural and attitudinal barriers to greater engagement, not least of which are the behavioural norms of academics themselves (Feltham 2007), and a hands-off approach is entrenched in policy:

We have not yet revised the action plan in the light of the strong concerns that HEFCE should do more to support the educator role. This is a challenging and sensitive area and we do not wish to do anything that might infringe, or be perceived as infringing, institutional autonomy. HEFCE (2009, p.6)

An illustration of an area displaying an apparent mismatch between institutional policy to reduce emissions and its educational mission is provided by international students. These are a significant source of income for many universities worldwide, they add to the cultural diversity of campuses and enhance the educational experience of fellow students. Internationalisation is a key agenda for many universities, and even though an important component of this is greater internationalisation of the curriculum through materials and examples from other countries and cultures, there is still considerable emphasis placed on international students and student mobility through educational exchange schemes. An unavoidable consequence of this are the associated greenhouse gas emissions. For example, consider the approximately 49,000 Chinese students studying in the UK in 2007/2008 (Table

3). Let us assume for the sake of illustration an average of one return air fare per year from Hong Kong to London for each individual, producing approximately 4.5 tonnes CO_2[6]. On this basis, emissions from these journeys alone exceed 220,000 tonnes CO_2 per year, and this crude averaging does not include in-country travel. This tension between the benefits and costs of internationalisation is likely to become a key issue for higher education institutions worldwide, both in terms of the ethics of increased air travel in an age of climate change, and particularly if these emissions are included in any future calculations of an institutions' total output of greenhouse gases. Of course, if air travel becomes prohibitively expensive for students owing to peak oil or carbon taxes or other disincentives (or a combination of both), then the financial model and student experience of many universities will have to be re-appraised.

Table 3. Subject of study and country of origin of students studying in UK universities in 2007 – 2008. Source: UK Higher Education Statistics Agency (www.hesa.ac.uk)

	UK		Other EU		China		Rest of world	
		%		*%*		*%*		*%*
Medicine & dentistry	52875	*2.7*	2420	*2.2*	255	*0.5*	6260	*3.5*
Subjects allied to medicine	267280	*13.6*	7560	*6.7*	620	*1.3*	11665	*6.5*
Biological sciences	146205	*7.4*	7375	*6.6*	905	*1.8*	7110	*3.9*
Veterinary science	4200	*0.2*	175	*0.2*	0	*0.0*	475	*0.3*
Agriculture & related subjects	15385	*0.8*	930	*0.8*	235	*0.5*	1125	*0.6*
Physical sciences	71765	*3.7*	4110	*3.7*	1095	*2.2*	5160	*2.9*
Mathematical sciences	27975	*1.4*	1805	*1.6*	1890	*3.9*	2450	*1.4*
Computer science	76080	*3.9*	5140	*4.6*	2655	*5.4*	11700	*6.5*
Engineering & technology	96920	*4.9*	11550	*10.3*	6645	*13.5*	24320	*13.5*
Architecture, building & planning	53870	*2.7*	3380	*3.0*	1260	*2.6*	4575	*2.5*
Social studies	169645	*8.6*	10285	*9.2*	3755	*7.6*	15190	*8.4*
Law	72740	*3.7*	4955	*4.4*	990	*2.0*	10560	*5.8*
Business & administrative studies	219690	*11.2*	22730	*20.3*	21015	*42.8*	47020	*26.0*
Mass communications & documentation	40860	*2.1*	2960	*2.6*	1110	*2.3*	3040	*1.7*
Languages	115210	*5.9*	9050	*8.1*	3710	*7.6*	8085	*4.5*
Historical & philosophical studies	88520	*4.5*	3260	*2.9*	210	*0.4*	4635	*2.6*
Creative arts & design	140340	*7.1*	8250	*7.4*	1360	*2.8*	8935	*4.9*
Education	191020	*9.7*	4360	*3.9*	980	*2.0*	5945	*3.3*
Combined	113735	*5.8*	1860	*1.7*	400	*0.8*	2310	*1.3*
Total	1964315		112150		49090		180550	

[6] Emissions calculated using www.carbonbalanced.org/calculator/flights.asp

The importance of academics engaging with the problems of climate change across all disciplines, including arts, humanities and social sciences has been stressed by Sir David King, the former Chief Scientific Adviser to the UK Government:

"[climate change] is also a problem that needs to be looked at from the social science point of view, economic point of view and political point of view, and universities need to address these problems in an interdisciplinary mode" (Times Higher Education, 24 January 2008)

The comments of Sir David were made in the context of interdisciplinary research, but the data in Table 3 emphasise the need the need to extend this argument to teaching. Table 3 shows the numbers of students in the UK studying different disciplines and their country of origin. Climate change research is likely to be concentrated in the disciplines of physical and biological sciences, and perhaps engineering and technology. (There will of course be individuals or small groups of academics with these interests in other areas, but my contention is that they are likely to be in the minority). Assuming patterns of teaching and curriculum content follow these research foci, it is clear that there are potentially large numbers of students passing through university without engaging with the issues as part of their curriculum. This is unintentionally reinforced by some of the professional associations in UK academia. The Higher Education Academy[7] supports good practice and sharing resources in teaching and learning across UK universities, and is arranged in Subject Groups. Resources related to climate change tend to be within the Geography, Earth & Environmental Sciences (GEES[8]) Subject Group, but many of these are technical and could only be readily understood by others within the discipline. It is also evident that some websites of faculties or departments engaged in climate change science have resources and activities available for schools and children. While this is laudable and should be encouraged further as part of universities' responsibility to engage with society, what of resources for non-specialist academics and students within their own institution?

For many of the more vocational undergraduate and postgraduate courses, curriculum content is strongly determined by the associated professional body. Examples at Leeds Met include nursing, physiotherapy, law, accountancy and architecture among others. In order to retain the accreditation of the professional body, and so attract fee-paying students, course designers need to meet the professional standards. In what may already be a full curriculum, negotiating where issues like climate change and sustainability fit in (and, crucially, dealing with real or perceived fears of what may therefore need to be left out) is a significant issue. Aside from courses with professional bodies, there are strong traditions of autonomy within higher education when it comes to designing and delivering a curriculum, and this continues to be articulated by the responsible public body:

HEFCE recognises that it is not within its role to influence the curriculum. However, we can support universities and colleges in producing graduates with the values, skills and knowledge to address sustainable development. This is important for all graduates, not just those engaged in fields directly connected to sustainability. Many will, for example, be managing or leading businesses or services where they will need to make decisions that impact on social justice or the environment.

Equally, we recognise the danger of bolting what some might see as the latest fad onto courses; doing so is more likely to create resentment than real change. So we will support

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[7] See www.heacademy.ac.uk/
[8] See www.gees.ac.uk/index.htm

shared curriculum ideas, content and assessment methods that help to develop teaching and learning. Different institutions will have different approaches. We want to encourage and incentivise engagement (including through our Strategic Development Fund) but recognise that there will be those who find it hard to engage because of their discipline base, the focus of their mission or the size or level of student interest. Our approach is therefore one of encouragement and support. HEFCE (2009, p.13)

While the newer policy on sustainable development is undoubtedly a step forward, the above extracts do not entirely remove some of the frustrations with earlier documents discussed by Ward (2007a). If the principal body responsible for policy and funding of higher education in England regards sustainable development as '*important for all graduates*' (my emphasis), why do they not feel they can influence curriculum, and can only offer 'support' for those institutions? The curriculum is already influenced in that there are strong drivers to incorporate employability, enterprise and personal development planning into all courses. Discipline base, mission, size and (perceived) level of student interest are no excuse for lack of action. As I showed earlier in the example of Leeds Metropolitan University, there are few, if any, disciplines to which it is not relevant, and it is certainly now relevant to every individual and organisation across the globe. It is the case though that many academics will not see the relevance to their subject or will be concerned about unbalanced or politicised teaching (e.g. see Cotton et al 2007). Nor would I argue that climate change should be developed in the curriculum uncritically. There are debates (however well- or ill-informed) about the nature of the evidence, the veracity and reliability of predictions, the extent to which any changes are human-induced, what, if anything, our response should be, and responsibility for and nature of actions to mitigate and adapt to changes. So aside from the subject of climate change *per se*, it is a highly valuable and topical tool for students to develop skills in critical analysis and balancing arguments, risks and uncertainties. This fits with universities' responsibility to prepare students to face the challenges of the twenty-first century world in their professional lives and as citizens. Broader concepts of ethics, justice and fairness can readily be addressed through climate change (e.g. Adger et al 2007; Garvey 2008).

It would be naïve to assume that incorporation of materials across the curriculum would instantly produce results. Education is a necessary but on its own insufficient condition to promote the necessary changes in behaviour – the gap between knowledge and pro-environmental behaviour is well known (see Kollmuss & Agyeman 2002). But without it no change is likely.

China
The capacity of the environment in China to cope with the growing pressures of population, development and economic growth is being stretched (Kitzes et al 2008). Unsurprisingly, there is wide regional variation in the causes and consequences of the issues. For a densely populated and highly developed area such as Hong Kong, its ecological footprint is largely a consequence of its importing of natural resources from other regions and the global commons, and carbon emissions released into the atmosphere as a consequence of power generation and transport (Niazi et al 2008). Summarising China's environmental problems, MacBean (2007) argues that while there are a range of policies and laws in place aimed at addressing them, their impact is limited owing to lack of compliance and conflicting pressures for economic growth and employment.

In 2007, the National Development and Reform Commission produced China's National Climate Change Programme (Anonymous 2007). As with any such document, there are issues with the scenarios and targets because of the time lag in collecting, publishing or

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reviewing data in such rapidly changing circumstances (e.g. see Anderson & Bows 2008). There is also China's stance, contested by some, that developed countries should take the lead in reducing emissions because of past activities. Liu (2009) offers a recent and succinct critique on climate and energy issues in China, encompassing the National Climate Change Programme. While noting some considerable achievements, like MacBean (2007) she comments on the disjunction between state policy and local buy-in:

Unfortunately, the state-led efforts have not sparked much enthusiasm from local governments and industries because of a lack of incentives. And the annual energy efficiency targets are rather arbitrary, with few considerations of the time frame needed by industries for such changes. As a result, the targets were not reached in 2006 or 2007. The policies and regulations do, however, indicate the central government's political will, and they have cleared many obstacles for optimal market functioning. (Liu 2009, p.86)

For the purposes of this paper, I do not intend to comment further on general climate change issues or policies within China, but will focus on those aspects of the policy which relate to higher education. Key sections of the document are:

Strengthening Education, Training and Public Awareness on Climate Change
The Government of China always attaches importance to education, training and public awareness on climate change. The Program of Action for Sustainable Development in China in the Early 21st Century states that China will vigorously develop all forms of education at all levels, to enhance the public awareness on sustainable development and enhance their scientific and cultural capacity for their participation in the sustainable development by reinforcing personnel training. In recent years, China has intensified its efforts to promote education, training and public awareness on climate change by organizing various kinds of lectures on climate change basic knowledge, conducting climate change training courses for policy makers at central and provincial levels, and organizing conferences such as Climate Change and Ecological Environment, as well as setting up an official bilingual website on climate change (China Climate Change Info-Net http://www.ccchina.gov.cn) in Chinese and English to provide comprehensive information on climate change. Commendable results have been achieved accordingly.(p.13)
Reinforcing the publicity, education and training on climate change. Measures in this regard include: making full use of mass media such as books, newspapers, periodicals, audio and video products to disseminate knowledge of climate change to stakeholders in all walks of life; advocating sustainable life style including electricity-saving, water-saving, garbage classification, reduction, recycling and reuse; incorporating climate change publicity and education into the framework of basic education, adult education and higher education as an important component of China's overall quality education; holding various thematic training seminars targeting at different audiences and organizing different workshops on both popular and professional climate change science; (p.55)
Public awareness. Capacity building needs for public awareness include developing medium-and-long term program and policy to enhance public awareness of climate change, establishing professional publicity and education network and institutions in line with international standards, training people working in media and climate change education, launching public campaigns for stakeholders from different regions and groups to disseminate the knowledge of climate change, and guiding the public consumption patterns in favor of the protection of global climate system. (p.62)

While many of these goals are laudable, there is a lack of indication of who is to take responsibility for the actions and how they are to achieve them. Higher education in China has changed rapidly in recent years, and this process is continuing (Ma 2003). There is still a strong rhetoric of centralised control and a proscriptive curriculum (e.g. Ministry of Education of PRC 2008a), and this approach can take away the flexibility and incorporation of locality-specific materials with which to engage students. These can include case studies of their own university as I have indicated earlier, and include specific examples of impacts if localised scenarios are available (e.g. Tracy et al 2006). In common with other countries, many of the specialist higher education institutions might not regard climate change as relevant to them. The latest data I have seen show that by 2002, 15% of young people were progressing to higher education in China, equating to 16 million people in over 2000 institutions (Ministry of Education of PRC 2008b). These are likely to be the future managers and leaders of society, and as Ma (2003) notes:

What specific missions and roles will higher education play in independent judgment, development of cultural and ethical values of society, besides economic development?

Conclusions
Universities have a key role to play in responding to the challenges of global climate change. They are the site of much research into our understanding of the science behind climate change, and are working with businesses, governments and non-government organisations on projects to develop technologies and actions for mitigation and adaptation. However, there is evidence that teaching in these areas is not always extending beyond the core areas of geography, earth and environmental sciences and some engineering. This lack of interdisciplinary working is hampering wider engagement and means that many students are passing through university without any critical engagement with climate change issues within their curriculum. This need not be the case. Universities also tend to be large organisations, playing a significant role in the city or region they are located. Through better management of their estate and energy use, and initiatives aimed at staff and students, such as transport, purchasing and recycling policies, they can demonstrate leadership to their communities and stakeholders, both internally and externally, and these can generate valuable teaching tools with which to engage students.

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