

CURRICULUM CHANGE FOR SUSTAINABILITY

Dr Carolyn S Hayles¹ and Sarah E Holdsworth²

¹School of Property, Construction and Project Management, RMIT University, Building 8,
360 Swanston Street, Melbourne VIC 3001, Australia

Email: Carolyn.Hayles@rmit.edu.au

²School of Social Science and Planning, RMIT University, Melbourne, Australia

Abstract

January 2005 saw the launch of the 'Decade of Education for Sustainability' and with it a number of initiatives to promote sustainability within the teaching of built environment disciplines. At the School of Property, Construction and Project Management, RMIT University, interest was generated by a project working to embed sustainability within the core curriculum of different schools across the university.

This paper explores the pedagogical research approach adopted, one which builds capacity through reflective teaching practice. The course contents of the undergraduate programmes managed by the School were audited to establish where sustainability was taught and where further content could be embedded. Staff members were encouraged to engage with the project team and develop their own understanding of sustainability. Sufficient resources were provided to relevant staff to make changes to their courses.

In addition, three new courses that have been developed to meet a need to further explore sustainability in the built environment are described in detail. Delivery of these new courses is significant as there has been a move away from the traditional lecture to a more hands on approach; one which makes it easier for the students to foster values and behaviours, deepening their understanding of sustainability.

Delivery of these courses evolved from traditional lectures to experiential learning. This approach has also given the students an opportunity to recognise the importance and complexity of sustainability and empower them to make sustainable decisions in their professional lives. Consequently the most successful way of engaging students and enhancing their awareness of the issues has been to personalise the experience, allowing them to take ownership of the notion of sustainability before looking at how this may be applied in their professional lives.

Keywords: challenge, embed, engage, students, sustainability education

1. Background

January 2005 saw the launch of the United Nation's 'Decade of Education for Sustainability' and with it a number of initiatives to promote sustainability within the teaching of built environment disciplines. At the School of Property, Construction and Project Management, RMIT University, interest was generated by a project working to embed sustainability within the core curriculum of different Schools across the university.

This one-year action research project, which was also launched in January 2005, focussed on embedding sustainability capability into core curricula at RMIT University. Its design was informed by insights from previous attempts to engage with sustainability education within RMIT. The project was developed to create lasting change in both organisational structure/operations and curriculum content. In doing so it was necessary to identify the key mechanisms required to up-scale and turn sustainability curriculum innovation into embedded practice.

RMIT has committed to several international declarations and internal policies that aim to ensure that environmental/sustainability education is addressed and implemented. These include the Tallories Declaration, RMIT's Teaching and Learning Strategy, RMIT Strategic Direction: A Sustainable RMIT and the Program Renewal Process. These agreements and policies commit the university to sustainability education, legitimising the aims of the project.

2. Pedagogical Research Approach

The Victorian Government's Department of Sustainability and Environment (DSE) Greenhouse Policy Unit provided the funding for the project, seeing it as an opportunity to meet the demand from industry for sustainability capabilities. While discussions with academics began with greenhouse and climate change issues it was soon realised that these paradigms epitomise the complexity of sustainability and the focus of the curriculum content evolved into the broader issues of sustainability (crudely reduced into concepts of environment, society and economics).

This project's aims were to identify some key mechanisms required to turn sustainability innovations into embedded practice in a university context. Specifically, the aims of the project were:

- To understand the drivers and barriers for/to curriculum change;

- To undertake a series of action research projects aimed at applying organisational learning and cultural change processes for embedding sustainability into the curriculum of a university;
- To develop a flexible change framework for *education for sustainability* for use by other academic units and universities; and
- To make general recommendations about the types of models and approaches that can influence organisational learning and change for sustainability.

The process sought to illustrate the need for alternative practice in delivering sustainability education across disciplines within a Higher Education Institution. In this context the process represents significant cross-campus collaboration between three Schools at RMIT (the School of Property, Construction and Project Management, the School of Management, and the School of Social Science and Planning); engendering a spirit of collegiality within and across discipline areas.

The project work was specifically focussed within these three Schools; with curriculum renewal focussed on two Schools (the School of Property, Construction and Project Management and the School of Management); with a core support team and identified academics from within these Schools to facilitate a process, tailored to the discipline area. This addressed the concern of Alabaster and Blair (1996, p 98) that academic staff "*...are often ideologically resistant to curriculum changes that emanate from outside the bounds of their discipline*". The project team had extensive experience in the provision of sustainability training courses and programmes and were involved in a range of research programmes and other projects relevant to their areas of expertise.

The selection of the two Schools was based on a champion from within each School who displayed understanding, sympathy and previous experience in attempting to integrate concepts of sustainability into their curriculum. Organisational change within institutions requires guidance and support from the top (Bekessy *et al.*, 2003), hence it was considered important to the success of the project to have upper management support. The 'Heads of School' from the School of Property, Construction and Project Management and the School of Management were actively involved and extremely supportive of the work that was conducted during the project's lifespan.

To ensure that staff within each School felt supported, engaged and empowered, the champions were engaged for one-year to work as part of the project team. The role of the champion was to co-ordinate activities within their School; utilising the opportunity for academic staff to

precipitate change. To overcome an identified major obstacle cited in actioning organisational change and curriculum renewal, namely “time”, the project budget was used to buy-out the champions from part of their daily activities.

A project co-ordinator was appointed to coordinate, develop the project methodology, assist and to act as a resource for the project team; assist the champions (such as with development of course plans); and to establish the website.

The project co-ordinator and the project champion (from the School of Property, Construction and Project Management) are the authors of this paper.

3. Approach Adopted

The key innovative feature of the project resided in the selected approach, that of *change management*. In contrast to seeking change through academics conforming with a centrally mandated, whole-of institution policy, this project recognised that educational change occurs through cultural changes in the way academics work with their disciplinary expertise, interact across interdisciplinary boundaries, and negotiate the forms, purposes and pedagogies through which knowledge and learning experiences are prepared for, and experienced by students (Fullan, 1999).

Hargreaves (1997) argues that embedding and scaling-up innovation is more a matter of re-culturing educational practice rather than merely restructuring curricula. The approach adopted in this project was one in which the *cultures of teaching* in the two Schools was the prime focus for educational change (Hargreaves, 1997).

Cultural change in organisations is most effectively managed as a process of learning through dialogue and praxis grounded in systems thinking (Senge, 1990). The project advocated a cultural change approach among staff in the Schools. This necessitated dialogical analyses of the knowledge forms, purposes and pedagogy that underpin curriculum development in order to facilitate the movement from reactive and adaptive modes of curriculum action to creative, reflective and generative modes (Kim, 2001).

The success of this project hinged on the appreciation of the context in which the work took place and the way in which the project was supported by key stakeholder groups within the university. The project required a contextual understanding of the pedagogy within the Schools, how sustainability’s understood, implemented and informed by professional industry bodies,

organisations and potential employer groups, and the day to day operations of the staff, so that they had the ability to complete the work and feel validated.

In order to create a process that was more likely to result in successful change, the project structure and methodology was informed by RMIT's past experience and identified obstacles associated with similar curriculum renewal projects and building in strategies to offset these.

The project recognised the key inhibitors to curriculum change and identified ways of reducing their effects. Cowell *et al.* (1998) identified three major barriers to change from their experiences in organisational renewal in tertiary organisation that can be summarised as a lack of:

- A culture of value or priority given to sustainability;
- Organisational and resource support for staff; and
- Training for academic staff.

In order to offset these barriers, the project team secured high level management support from the Heads of Schools, ensuring that staff saw the project to be important enough to build into their activities. As well as recognition that *curriculum change for sustainability* required not only senior management support to ensure staff believe the project to be important enough to build into their activities, but also a 'bottom-up' approach. Meima (1997) comments that commitment from key individuals and charisma can be very important in initiating and sustaining change. The role of the academic champions was therefore vitally important as they had valuable insight into the culture of the Schools and an understanding of the discipline area; assisting in the identification of subjects/modules where sustainability content could be embedded.

Another identified major obstacle cited in actioning organisational change and curriculum renewal is time. This was overcome by allocating part of the project budget to financially resource the academic champions from some of their daily activities to specifically work on this project. This was especially important, as previous curriculum renewal projects conducted at RMIT have been unsuccessful at facilitating lasting curriculum change. While those involved in the RMIT studies in the past have expressed strong interest in sustainability education other areas of resistance have dissuaded them from developing this focus in their teaching. Thomas (2005) suggested that resistance may come from the financial and administrative difficulties of developing cross-departmental (usually cross-disciplinary) initiatives.

The two major factors controlling the structure and functioning of academia, namely disciplinary structure and economics forces, have proved to be a barrier to moving universities towards more sustainable practices. However, the funding allocation and structure of the project allowed for the

project team and has provided those involved with the project time to learn, think and develop sustainability curricula within their School.

4. The School of Property, Construction and Project Management

Course audits

The course contents of five undergraduate programmes managed by the School of Property, Construction and Project Management were audited to establish where sustainability was taught and where further content could be embedded.

The results of the audit provided an insight into the attitude of staff from within the School towards *education for sustainability*. Sustainability was believed to be relevant to student learning and there was recognition that the concept is being taken seriously by industry. However, many barriers to its inclusion into course curricula were identified. These included a lack of content knowledge of the concept, time, crowded curriculum, student interest, financial resources, and the identification of sustainability issues relevant to course subject matter. The results also indicated that individuals are willing to work towards building sustainability concepts into their courses if provided with some assistance in the form of:

- Content identification and development;
- Case studies;
- Role plays,
- Video clips;
- Co-teaching/joint supervision;
- Literature reviews;
- Access to guest speakers; and
- Better quality research.

The identification of courses actually containing sustainability concepts was not quite as clear. The results ranged from subjects that claimed to teach sustainability in its entirety to not at all. In one instance course audits completed by two individuals co-teaching the same subject completely conflicted, one suggesting sustainability was covered in its entirety; the other claiming there was no sustainability content whatsoever. The project team took this to mean that there was a high level of confusion and different interpretation of what sustainability was in

relation to the curriculum of the discipline, reinforcing the relevance of the next stage of the project, an action-learning workshop.

Action-learning workshop

This half-day workshop allowed academics within the School to come together and discuss the role of *education for sustainability*. Initial attitudes towards sustainability teaching varied:

“...It has nothing to do with me.”

“...Someone already teaches sustainability so I don't need to cover it in my course.”

“...I already teach sustainability so I don't need to be here.”

“...How can you help me find materials.... I'd like to do more!”

The internal and external speakers provided a common platform from which to begin discussion within the workshop and were useful in clarifying the relevance of sustainability in the School's curriculum. They also reinforce the need for current and future graduates to have understanding and skills in sustainability providing examples of relevant sustainable business practices. Part of the discussion was around whether sustainability should be taught in stand-alone courses or as integrated material in the existing curricula. The outcome was an agreement that integrated concepts with the entire curriculum should be the ultimate outcome, but there was recognition that this could take time.

To ensure sustainability was retained within the curriculum it was agreed that the one stand-alone course should be retained as a starting point, and that work to integrate sustainability concepts within the existing curriculum would continue.

The workshop provided a platform to demonstrate the importance of sustainability to graduate outcomes and staff recognised the need to begin to think about the concept and how it could be built into curriculum. The workshop provided a forum where academics could develop their own thoughts without being told how they should do things.

As a consequence of the workshop, academics interested in taking part in the project were identified and small action teams were established. These teams were made up of academics from within the school, the project champion, and the project coordinator.

Course development

As a direct result of this project, three courses have been developed or rewritten to consider sustainability (sustainable buildings and green construction) in a number of different ways. The general approach taken follows a methodology previously developed by Graham (2000) and

outlined in his paper “Building education for the next industrial revolution: teaching and learning environmental literacy for the building professions”. Graham (2000) describes a successful method of teaching applied to third-year construction management students within the School, namely the teaching of sets of principles that describe both the personal attributes of the student and the nature of their actions. This approach enables them to describe their professional approach and the reasons for the decisions they make as construction professionals.

The degree to which a student has embodied these principles will be demonstrated through their understanding of a number of key concepts. Students must also learn tools and methods that allow them to demonstrate that they understand the concepts, and apply them in problem contexts to solve resource and environmental problems (Graham 2000).

Research and sustainability

Research and sustainability is a new third-year course, which has been developed to ensure that students’ understanding of research informs their ability to critically examine sustainability. The students are taught sustainability principles using different research methods so that they better understand the often-complicated decision making that surrounds sustainability issues. They also have the opportunity to visit innovative green building projects, undertake building audits, question experts in the field, and study their own impact on the environment using interactive web-based tools. Students carry out group-work research in an area of sustainability. In addition they are asked to complete an independent literature review on a topic relating to one or more aspect of sustainability, showing that they have grasped the key concepts and can apply critical thinking in their approach to developing a research question for their final year project.

Affordability and sustainability study tour

The Affordability and Sustainability Study Tour is also a new course; an elective open to all students within the University. Students attend seminars and site visits in both Melbourne and in Auckland, New Zealand where they are given the opportunity to compare methods of eco-assessing domestic building designs. They will also look at key environmental issues and adaptive housing designs. Students must complete an assignment to demonstrate an understanding both in wider sustainability and affordability issues as well as looking at current best practice in housing development. They are asked to produce housing plans for a specific location taking into consideration issues that may impact on sustainability performance and long-term affordability. To complete the course, students are invited to present, in an open forum, the key challenges they experienced in planning for sustainability and critically explore whether, in their opinion, housing sustainability must be driven by the house builder or the consumer. It is

hoped that this hands-on approach will mean that students are better equipped to tackle complex issues in their own professional practice (Hayles *et al.*, 2006).

Environmental management (offshore)

The pre-existing third-year Environmental Management course taught in Singapore has been redesigned to embrace sustainability and green building. This intensive course, which is taught over six consecutive days, now includes local site visits to world-class sustainable buildings, practical workshops, an on-site building (sustainability) audit and an opportunity for students to study their own impact on the environment through interactive web-based training tools. There is also a seminar on the Asian response to The Kyoto Protocol, the global climate treaty, the new Asia-Pacific climate pact (the Asia-Pacific Partnership on Clean Development and Climate), and an opportunity to look at various innovative projects from across the region (Hayles & Holdsworth, 2005).

Embedded sustainability content

An additional seven first-year and second-year courses, across the four disciplines within the School (construction management, project management, property and valuation), have been identified and core themes of sustainability are being embedded.

It is intended that the development of new course material with a sustainability focus for existing courses in these four streams will provide students with grounding in sustainability (theory and practice) and a solid foundation for specialist sustainability subjects, including the elective, recommended for third year students.

5. Discussion

Approaches to curriculum renewal and course development

At the outset it was recognised that *education for sustainability* was going to be a challenge for the educators, given traditional didactic strategies are inappropriate, and that the material can be complex and require new ways of thinking and presenting (Papadimitriou, 2004).

Material development as part of the project focussed on curriculum that allows students to learn how to think in a more integrated fashion. This approach is supported by the work of The United Nations Commission on Sustainability (UNCSD) and the United Nations Education, Scientific and Cultural Organization (UNESCO) who have consistently emphasised an interdisciplinary

approach to teaching and learning in higher education, and the reorientation of teacher education to reflect this priority (Calder and Clugston, 2003).

The sustainability course audits were useful for mapping out how and where sustainability was being taught in the current curricula of the School's undergraduate programmes. The degree to which sustainability concepts were built into programmes and the form that this took (i.e. modules in existing courses or new sustainability courses) was determined by the level of acceptance of relevance and commitment of the teaching academics.

Where possible the project focussed on embedding sustainability capabilities into as many courses across the curriculum, so there was an integrated learning outcome for the students where sustainability formed an implicit part of their learning within the discipline as opposed to an add on consideration. Where this was not possible, to ensure that students within the programme had some exposure to *education for sustainability*, stand alone sustainability courses were designed in such a way that the course content reflected the knowledge and skills students would need to improve their personal and professional practice upon graduating.

Consequently new curriculum material was developed with the goal of student learning outcomes that focussed on current and potential professional values and practices in this context. Content was structured so that all students at some point within their studies would understand some or all of the following:

- How their discipline area and professional practice functions and affects the natural environment (e.g. its sources of food, water, energy, endpoint of waste) and its contribution to a sustainable economy;
- How their discipline area and professional practice builds social capacity (such as, how employees are involved in decision making, their status and benefits etc); and
- The basic values and core assumptions present in the content and methods of their academic discipline (Clugston & Clader, 1999).

Scientific complexity of the sustainability paradigm

One of the barriers to property and construction students understanding sustainability principles is the level of scientific complexity involved in the material. When developing suitable curriculum it was necessary to determine the level and depth of the science involved, so that students could acquire the minimum scientific knowledge to allow them to understand the subject material. For example students do not need a three-hour lecture on environment cycles to understand that the earth is a closed system.

However, it was also recognised that when developing curriculum content it is easy to simplify the complexity too much so that sustainability education becomes about solutions (e.g. the development of a grey water recycling system, a water tank or the production of a triple bottom line report), and the theoretical underpinnings of these initiatives are lost. Students must be made aware of both causes and prediction affects, of the uncertainty surrounding them, as well as of its economic, political and social dimensions, if they are to be able critically think, reflect and act personally and professionally in alternative ways.

A student who has grasped the concept of sustainability will understand that human actions have complex environmental and normative consequences. The student that has the motivation and education to investigate and pursue courses of action is more likely to contribute to a more sustainable future (Strauss, 1996). Understanding the problem is fundamental to constructing the solution, and not prescribing solutions is fundamental to encouraging creativity, a key component of the integrated design approach (Hayles and Fong 2005).

Personalising the experience

In addition to developing alternative course curriculum, another focus of the project was to find alternative and appropriate methodologies for teaching these complex issues.

The traditional ways of teaching, based on transmission of knowledge, are inappropriate, as they do not help students to use the knowledge learned to understand real issues from everyday life (Papadimitriou, 2004). In order to empower students to successfully achieve sustainability literacy they need to understand the difference between current practice, resource efficient approaches and new systems thinking in their chosen professions. One way of achieving this is to use problem-solving approaches. There is a need to teach approaches to design and management decision-making as well as the tools and techniques for solving problems and finding solutions. The use of case studies and guest lectures to demonstrate concepts and tools that have led to unsustainable as well as sustainable solutions, is one method used to allow students to develop such knowledge (Hayles and Holdsworth, 2005).

As a result, a move away from the traditional lecture style of teaching to a more hands on approach was emphasised, one which makes it easier for the students to foster values and behaviours, deepening their understanding of the issues, and allows them to recognise the importance and complexity of the decisions they will be asked to make in their professional lives. This approach involved challenging preconceptions and convincing students that they can do have opportunities to make a positive difference in working towards a sustainable future.

The use of rigorously designed material, material designed to stimulate discussion between students working in small groups, plays a decisive role. As a result there was a move away from

the traditional education delivery style, the lecture, to a more hands on approach, one which makes it easier for the students to foster values and behaviours, deepening their understanding of the issues, and to recognise the importance and complexity of the decisions they will be asked to make in their professional lives.

Other teaching devices applied include didactical interventions; focussing on relating issues of sustainability to students' personal lifestyles (Lenzen *et al.*, 2002). In some students this approach has acted as a stimulus, encouraging them to learn more about how these issues may impact on both their personal and professional life choices.

Indeed, the work on curricula within the School revealed that one of the most successful ways of engaging students and enhancing their awareness of the sustainability issues was to personalise the experience, allowing them to take ownership of the notion of sustainability.

This shift in style and delivery of courses facilitates the incorporation of web-based educational tools. Sustainability tools such as the Ecological Footprint (<http://www.myfootprint.org/>) and the Australian Greenhouse Calculator (<http://www.epa.vic.gov.au/Greenhousecalculator/>) allow students to scrutinise their ecological footprint, annual energy consumption, and discuss within their groups how they consume, reuse and recycling.

Using the Greenhouse Calculator and the Ecological Footprint in teaching has stimulated interesting and controversial discussions not just about the focused questions but also about ethical topics such as equity and responsibility. By allowing students to critically question their own experiences of sustainability, they can examine the way they interpret the world and how their understanding and opinions (morality and ethics) are shaped by their 'sphere of influence'.

These outcomes are then directly related back to decisions they may make within their industry regarding the reuse and recycling of existing building structures and materials, jobsite waste management, choosing and educating suppliers for environmental purposes, or even the development of initiatives to offset such wastes as ethical investments or cultural change programmes. This in turn allows the tutor to demonstrate how sustainability influences current practice and how future professional practice may change as legislation and building regulations in support of sustainability are brought to the fore.

6. Conclusions

Higher Education can be very innovative and adaptive, as proven by the outcomes of the collaborative curriculum renewal project described in this paper. The project, funded by the Victorian Government's Department of Sustainability and Environment (DSE) Greenhouse Policy Unit, sought to embed sustainability principles within course content of non-traditional disciplines, including courses delivered by academics in the School of Property, Construction and Project Management.

Achieving comprehensive *curriculum change for sustainability* within this School will take time. The courses that have been developed and adapted as a result of this project, and outlined in this paper, are only the beginning; however there is now a structure in place and potential for change. It is hoped that the United Nation's 'Decade of Education for Sustainability' will provide further stimulus.

The unique aspects of this project was that it included a highly collaborative, interdisciplinary project team; the provision of financial support to academic champions in each of the Schools to allow time to be committed to the project; and the focus on making sustainability content relevant to each discipline and capabilities desired by industry.

One of the most important achievements of the project was early recognition that for this curriculum renewal exercise to be successful, it needed to fit within the culture of the Schools taking part, and that the project needed to be owned and driven by the academics. These aspects were essential given the inherently contested nature of *education for sustainability*; the concept itself can only truly be understood and seen as relevant if it is first personalised, and then placed within a specific context (the curriculum of the specific discipline and course).

In January 2006 the project team were awarded an additional grant from the Australian Research Council to continue this work for a further three years and to role it out to other Schools within the University.

7. Acknowledgements

The authors would like to thank the Victorian Government's Department of Sustainability and Environment (DSE) Greenhouse Policy Unit for funding the 'Sustainability Education at RMIT' research project and the academics from the School of Property, Construction and Project Management at RMIT who have supported and contributed to the project by ensuring Sustainability content is embedded in the courses that they teach.

8. References

- Bekessy S, Burgman M., Wright T., Filho W and, Smith M (2003). Universities and sustainability. *Tela Papers* No. 11.
- Calder, W. Clugston, R. (2003). Progress toward sustainability in higher education. *Environmental Law Reporter*. Vol. 33, pp. 10003-10022.
- Clugston, R. Calder, W. (1999). Critical Dimensions of Sustainability in Higher Education. *Sustainability and University Life*. Walter Leal Filho (Ed) Peter Land, Germany.
- Cowell, S.J., Hogson, S.B. and Clift, R. (1998). Teamwork for environmental excellence in a university context. Moxen, J. and Strachan, P. A. (1998). *Managing Green Teams*. Greenleaf Publishing, Broom Hall, pp131-144.
- Fullan, M. (1999). *Change Forces: The sequel*. Falmer Press, London.
- Graham, P. (2000). Building Education for the Next Industrial Revolution: Teaching and Learning Environmental Literacy for the building Professions. *Construction Management and Economics*. Vol. 18, no. 8, pp. 917-925.
- Hargreaves, A. (1997). Rethinking educational change: Going deeper and wider in the quest for success. In A. Hargreaves (Ed.) *Rethinking Educational Change with Heart and Mind: 1997 ASCD Yearbook*. Association for Supervision and Curriculum Development, Alexandria, VA, pp. 1-26.
- Hayles, C. S. and Fong, P. S. W. (2005). Managing knowledge through value management for sustainable project solutions. Shafii, F. and Othman, M. Z., (Eds) *Proceedings of the conference on Sustainable Building – South East Asia (SBO4 Series)*. Kuala Lumpur, Malaysia, 11-13 April 2005.
- Hayles, C & Holdsworth, S. (2005). Constructing stimulus: teaching sustainability to engender change. *Fabricating Sustainability: Proceedings of the 39th Annual Conference of the Architectural Science Association*. 17 - 19 November 2005.
- Hayles, C. S., Robson, K. and Holdsworth, S. (2006). A case study from RMIT: Introducing property undergraduates to the immediate issues of housing sustainability and affordability with Australia and New Zealand. *Proceedings of the 12th Pacific Rim Real Estate Conference*. Auckland, New Zealand, 22-25th January 2006.
- Kim, D.H. (2001). *Organizing for Learning: Strategies for knowledge creation and enduring change*, Pegasus, Waltham.
- Lenzen, M., Dey, C., and Murrey, J. (2002). A Personal approach to teaching about climate change. *Australian Journal of Environmental Education*. Vol 18, pp. 559-576
- Meima, R. (1997). The Challenge of Ecological Logic. Welford, R. (Ed) *Corporate Environmental Management 2: Culture and Organizations*., Earthscan, London, pp. 26-56.

Papadimitriou, V. (2004). Prospective Primary Teachers' Understanding of Climate Change, Greenhouse Effect, and Ozone Layer Depletion. *Journal of Science Education and Technology*. Vol. 13, No. 2, Plenum Publishing Corporation.

Senge, P. (1990). *The Fifth Discipline: The art and practice of the learning organization*, Random House, New York.

Strauss, B. H. (1996). *The Class of 2000 report: Environmental education, practices and activism on campus*. Dennisport, M. A. The Nathan Cumming Foundation.

Thomas, I (2004). Sustainability in tertiary curricula: what is stopping it happening?. *International Journal of Sustainability in Higher Education*. Vol. 5, No. 1.