Encouraging cultural awareness in engineering students

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***Abstract**: With ever diversifying engineering student cohorts, faculty, and ultimately, engineering workforce, there is an increasing need to foster genuine cultural intelligence and awareness in students. An in-depth audit of graduate attribute-oriented learning experiences in engineering curricula at the University of Wollongong, identified a very limited number of learning experiences targeting cultural intelligence. This paper describes a project aimed at developing learning activities to improve the cultural awareness of first year engineering students. Crucially for the project, activities had to be developed with 'nuts and bolts', or 'formulae' focused engineering students in mind. Concepts of Critical Consciousness and self reflection have been cunningly disguised in activities that are directly relevant to engineering, and more specifically the area of engineering design and innovation. Stimulus material, discussion and design activities are packaged for a series of one hour tutorials to be run in conjunction with more traditional design and drawing tutorials. Evaluation of the effectiveness of this approach using a quantitative survey and qualitative focus groups is due to be completed in the second semester of 2010.*

Introduction

Engineers have long suffered under various stereotypes that usually incorporate some degree of social ineptitude and cultural ignorance. Recognition of these and other issues goes back some years now. The Institution of Engineers, Australia released the report 'Changing the Culture' (Institution of Engineers Australia, 1996) which recommended changes to the way engineers are educated. These recommendations developed into a set of 'graduate attributes' (Bradley, 2006) that closely resemble sets of graduate attributes (or qualities, or capabilities) adopted by universities around Australia and overseas.

Since 1996, Australian engineering schools have been coming to grips with the idea of 'graduate attributes' and how they can be incorporated into engineering curricula. While things like problem solving, teamwork, and written and oral communication have been the centre of many studies and engineering educational development projects, other attributes like ethics and cultural intelligence remain hovering dangerously close to the 'too-hard' basket. A comprehensive audit of graduate capabilities oriented learning activities in six engineering degree programs at the University of Wollongong in 2008 highlighted significant gaps in the curricula in terms of the graduate capability 'respect for views, values, and culture of others'. Investigation of how this gap might be closed drew forth a number of interesting themes:

- Many engineering education literature sources discuss the growing need to prepare engineers to work in an increasingly globalised workplace (e.g. Rhamdhani *et al*., 2009; Becker, F. S., 2006;

Lohmann *et al.*, 2006). However, educators' awareness of literature outlining how to improve cultural awareness and intelligence in engineering students is often limited.

- Despite the multicultural nature of engineering faculty in Australian universities, little advantage is being taken of this to educate students on cultural issues in a formalized manner.
- Popularity of educational programs that incorporate cultural issues such as Engineers Without Borders Challenge is increasing.

These initial themes can be summarized thus: Acceptance of the need for developing cultural intelligence in engineering students is present, and a wealth of cultural knowledge to facilitate this is available. However, the knowledge among engineering academics on how to effectively educate engineering students on cultural issues appears to be lacking.

In early 2010, the authors obtained an internal grant to investigate how it might be possible to teach undergraduate students a greater awareness of, and respect for cultural issues in engineering. The implementation of this was to be a first year creative design course which, conveniently, was to run in conjunction with the Engineers Without Borders Challenge (EWB, 2010). In line with the 2010 EWB challenge, and also local relevance and importance, Australian Aboriginal cultures were to be emphasizes in the development of teaching strategies and resources.

Theoretical Framework

Work on this project begun with establishing the theoretical framework with which to move forward. This meant understanding accepted models of culture and some of the mechanisms with which culture effects behavior and the development of built environment that surrounds us. Hofstede's (2001) research on culture's consequences has had high levels of currency for over 20 years. He starts his exploration with a longstanding anthropological definition, that culture:

> *[…] consists in patterned ways of thinking, feeling and reacting, acquired and transmitted mainly by symbols, constituting the distinctive achievements of human groups, including their embodiment in artifacts […] (Kluckhohn, 1951, in Hofstede, 2001, p. 9).*

Visible manifestations of culture include symbols (words, gestures, pictures and objects); heroes (highly prized models of behaviour, alive or dead, real or imaginary); and rituals (collective activities that are technically unnecessary but considered essential to membership) (Hofstede, 2009, pp. 10-11). The dimensions of culture that Hofstede (2001) identifies are:

1. *Power/Distance:* how inequalities in prestige, wealth and power are handled, within the family, education, work, politics, religion and ideas;
2. *Uncertainty Avoidance:* how uncertainty about the future is handled, with artifacts addressing the uncertainties of nature; laws (rules), the behaviour of others; and religion, what we do not know;
3. *Individualism/Collectivism:* what the relationship is between the individual and the collective;
4. *Masculinity/Femininity:* what gender role patterns are, and how highly differentiated the roles are;
5. *Long-term/Short-term Orientation:* whether the focus is on gratifying short-term needs or responding to longer term social and moral obligations.

All of these visible manifestations, and the five dimensions of culture, could be drawn upon in students' critical examination of the influence of culture on their Engineering practice.

Critical pedagogy, such as is being used here, has been heavily influenced by the work of Paolo Freire, a Brazilian educator. In Freire's view, education is not neutral, but either serves the interests of the powerful, or empowers people to act in their own or others' interests; students are not empty vessels, but have unexamined assumptions about the worlds in which they live, which, when examined supportively through dialogue, are the starting point for learning for students and teachers alike. Freire, like Hofstede, drew on anthropological views of culture, suggesting that grasping the distinction between culture and nature (everything that would exist without people being there) is the first step towards self-awareness and self-belief. People can be lifted out of seeing their situation as

'natural' and unchangeable, to engage in dialogue and actions that can change the world they live in (Freire, 2007).

Kirkwood and Kirkwood (1989) provide detailed accounts of how they implemented Freire's ideas in disadvantaged communities in Scotland. This included selecting, along with community members, situations that best represented typical experiences for those living in the area, in order to unpack them. Once drawings or photos of these typical situations had been created, the typifications were explored using a planned sequence of questions (decoding), generating themes that were used to build locally relevant curricula. Several detailed examples reveal how they worked using these visual materials; the underlying framework involved three different levels of questioning: descriptive, affective; and interpretive/analytical (e.g., Kirkwood and Kirkwood, 1989, p. 62). It is upon this decoding stage that we would be drawing.

We also needed to take account of several other factors: firstly, that the students were to develop an Engineering solution to community-identified problems for the EWB challenge, and therefore they were one-step removed from the direct involvement typical of work that draws on Freire's ideas. Secondly, students were likely to have stereotyped assumptions about Aboriginal communities. Thirdly, they would be working in teams. And finally, they were unlikely to respond positively if all of this socially-oriented material was to be provided outside of an Engineering context.

In terms of the first and second issues, the Indigenous community could be seen as commissioning the projects that students were pursuing and for which they were 'tendering'. How might we move students from seeing the knowledge amongst remotely located Aborigines as somehow lesser than theirs, but, rather, have them see Aboriginal knowledge as legitimate, and value it? We needed to ensure that students were working from a basis of profound respect for Aboriginal culture. According to Mclaughlin and Whatman (2008), critical race theory suggests there is a need to:

- problematise the endeavour of embedding Indigenous perspectives;
- have students deconstruct their own cultural situatedness in order to appreciate the ways in which the "other" is framed;
- overcome the hegemonic and appropriating capacities of "Western" disciplines and the dissonance between Indigenous and "Western" ways of knowing;
- recognise the complexities of interactions at the cultural interface and the difficulties of achieving cross-cultural understandings and acquiring cultural competencies;
- reorient curricula by engaging with alternative ways of knowing and alternative skill sets (Williamson and Dalal, 2007, in Mclaughlin and Whatman, 2008).

Thirdly, and linked to these goals of culturally appropriate engineering solutions to clients' needs, students were learning how to work in teams. Whilst teamwork is generally to be found as a graduate quality desired by employers, critical education, too, starts with collaborative processes, and involves interacting with communities in ways that emphasise self-determination, co-ownership of processes and outcomes, open participation and distributed leadership – respectful and responsible involvement (Smyth, Angus, Down, & McInerny, 2008).

Finally, there was a general feeling amongst staff that direct engagement with these concepts was unlikely to generate enthusiasm amongst students in their first year of study – they would see this as an unusual and somewhat unwelcome departure from their largely technical field. In terms of tutorial design, getting students to the point of considering troubling new perspectives involves concealing the path forward until you judge it time, and helping students reflect on their 'reality' in a process of thoughtful action (Brookfield, 2006, p. 13); Mayo 1999, in Matheson and Matheson, 2008, pp. 31-32). Given that the starting point for any journey towards cultural competence is often the jolt of the unfamiliar against 'mindless adherence' to culturally acquired rules and traditions, to the extent that differences are not even noticed (Thomas & Inkson, 2004, p. 66), we needed to start with an exploration of students' current understandings. With this background in theory and effective practice, attention turned to the development of a set of tutorial plans and associated learning resources.

The First Tutorial

In the first tutorial, an icebreaker, involving self-introductions and a brief account of who or what interested them in Engineering, begins the process. This is a relatively rapid but personal process that allows the tutor to debrief around the subject's focus on people, objects and principles in interaction with each other. Students then form teams, and decide upon roles and processes. Then the process of exploring assumptions begins, using cultural artifacts as the stimulus for exploring ideas. Students first draw a plan of the home in which they grew up, identify where engineering comes into this, and then compare these drawings against homes in a variety of other cultures (rural China, rural NSW, Czechoslovakia, India, Japan, etc.), whilst a series of slides containing images of these places is displayed in a continuous loop. In this exercise, space and place matter. The language of exclusion is spatial and notions of place highlight local knowledge, celebrate local responses, and foreground the views of those to whom solutions matter (Smyth *et eal.*, 2008, p. 2). Space and place matter also, and most particularly in terms of Aboriginal culture, where place and identity are inseparable. The points of comparison are based on Kirkwood and Kirkwood's (1989) three levels of understanding. New groups are formed with representatives from each previous group, to examine their findings in terms of a range of ecological factors considered to be the origins of culture, including geography, history, demography, hygiene, nutrition, economy, technology and urbanisation (Hofstede, 2001, p. 12). The final discussion involves a consideration of how culture might be affecting artifacts other than houses in which engineers play a role.

In simpler terms, this tutorial encourages students to consider how their own culture and values dictate the where and how they live (or at least want to live) by contrasting this with the way others live. They are challenged to justify why their house ended up being designed the way it was when considering some different, yet equally effective design solutions.

The Second Tutorial

The second tutorial is overtly focused on Engineering method, following the model provided in Dowling, Carew and Hadgraft (2010). Covertly, students are being asked to practice responding to a brief which features an unfamiliar set of cultural assumptions. They are asked to design a school, with the brief specifying aspects of culture identified by Hofstede, expressed in lay terms. Each sub-group also has an extra requirement to meet, drawn from recent research, to facilitate their use of the Engineering method. Once they have worked through the required steps, new groups are again formed to discuss their ideas, and the implications of this wide variety of ideas for their own designs. The last part of the tutorial is devoted to students revising their design briefs, for submission to the tutor as an assessable task.

Week Three Lecture

Between the second and third tutorial, a guest lecture is given by a local Aboriginal cultural advisor. The intention for this lecture is to bring in a face to face connection with the local indigenous community, and to present some of the real issues surrounding the Indigenous-European Australian cultural interface. This guest lecture is deliberately overt, as hopefully, the spark of interest will have been lit by the first tutorial, and the introduction of the EWB challenge. The manner of presentation of this lecture will be through narrative, a glimpse into the experiences of an indigenous community member growing up in the local area.

Week Three Tutorial

The third and final tutorial blends planned tutorial activities with the development of projects for the EWB challenge. In the third tutorial, a case study is presented via a news film on the relief in Aceh since the 2004 tsunami (Brown, 2010). Students are asked to consider the impact of community consultation and cross-cultural interactions on the success or failure of rebuilding projects in the Tsunami affected regions. The stimulus material highlights in particular Hofstede's cultural dimensions *Individualism/Collectivism* and *Long-term/Short-term Orientation* and the effect opposite values can have on an engineering solution. Students are challenged to consider the effect of culturally inappropriate engineering solutions in contrast with superficially similar, but more

successful solutions developed through a more culturally sensitive design and project management approach.

Evaluation Approach

The tutorial plan presented here is a pilot project, with a view to implementing further engineering contextualized learning activities across the curriculum in the future. This implementation is very much a 'testing the water' exercise to see how students and staff respond. The evaluation approach being developed is of qualitative nature. The authors, in collaboration with the coordinators of the first year design subject, have anticipated a number of potential issues which the evaluation is designed to explore. The key questions are:

- Will students engage with the tutorial activities in a meaningful way?
- Will tutors engage with the tutorial activities?
- Will students be willing to contribute their own personal experiences to the group?
- How effectively can tutors encourage deep discussion among students?
- Will students adapt the ideas of cultural influence from the first two tutorials to their EWB designs?
- Finally, are other subject coordinators likely to want to adapt a similar approach to other subjects?

From the tutors' perspective, these issues will be discussed during weekly tutor preparation meetings. Concerns expressed by tutors, as well as enlightening and positive in class experiences will be recorded to form an overall picture of the class dynamic. Students views will be collected upon completion of the three tutorials through a simple paper based survey. Emergent and interesting themes from the survey will be fed into structured individual student interviews to obtain further details on how the tutorial activities were received and whether or not students' gained any deeper understanding of cultural issues.

Finally, samples of students' final design reports will be assessed to identify any uptake of the ideas on culture contained in the tutorials, as well as in the online EWB support materials. The authors anticipate presenting some preliminary findings at the conference in December.

Conclusion

Improving undergraduate engineering student cultural awareness is an issue of ongoing importance, not only for their professional success, but for the people whose lives are impacted by engineering projects in the future. The Authors have proposed a small scale approach to initiating education in this area through the use of critical pedagogy and accepted principles of cultural influence. With this, it is hoped that students can improve critical awareness of the cultural norms and values that influence their own ways of working and behaving, and eventually translate this understanding to appreciating the cultural norms of others. While questions still remain over the implementation of these tutorials, the fact that such an approach has been accepted and adopted into a long standing first year design subject is a very positive start!

Acknowledgements

Support for this work has been provided by the University of Wollongong Educational Strategic Development Fund 2010. The Authors would also like to acknowledge the significant support contributions to this work by Jade Kennedy, Peter Wypych, Jayan S Vinod, and the tutors of ENGG154.

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