How are engineering graduates prepared to work in a culturally changing world?

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Abstract: *Engineering graduates need to be able to "perform professionally/socially in an international and multicultural environment" (OECD). They need to be aware of the socio-cultural, economic, geographical aspects in the particular environment they will be contributing to. This paper examines how an Australian university engineering faculty, in their local and offshore campuses preparing engineering graduates to be adaptable in an international and culturally diverse environment. Data generated from surveys carried out at the two campuses highlighted some interesting responses from both local and international students. This paper shares their responses to questions relating to how they currently view their profession in the global environment and how well they feel they are being prepared to work in diverse culturally mixed global environments. The paper will conclude with a description on how one discipline group is planning to trial some class work changes that is intended to enhance cross-cultural engagement among students.*

Introduction

The engineering practice is continually changing following the current local and global needs. Although the fundamental and technical knowledge that shape the foundation of engineering is universal, the practice of engineering may vary in relation to the environment in which the engineer finds him/herself working, which may affect the approaches taken for planning, design and construction to get optimal solutions. Grear (2006) suggests that the concept of an engineer based only in one country may be considered irrelevant as more engineers work across international boundaries. Grear (2006) identified that 40% of Australian engineers are working internationally whether they leave their desks or not. This implies that engineering graduates need to be "internationalised", i.e. aware of and sensitive to the local and global environments in which they will be working.

Engineers Australia (EA) recognises the dynamic nature of the engineering profession in a global environment by prescribing an attribute requiring graduates to be *able to function effectively as an individual and in multi-disciplinary and multi-cultural teams, with the capacity to be a leader or manager as well as an effective team member* (Bradley, 2006). This to ensure that engineering graduates from Australian Universities will be competitive and recognised by equivalent professional bodies overseas (e.g. signatory of the Washington and Sydney Accords).

Swinburne University of Technology has adopted a 2015 Statement of Direction (2009) stating that *"staff and students will be entrepreneurial in their work, international in their outlook, and intersectoral in their approach"*. The university also aims for the graduates to be *aware of local and international environment in which they will be contributing (e.g. socio-cultural, economic, natural)*, (Swinburne Attributes and Skills, 2009).The university intends to further develop international perspectives through learning and teaching programs that will hopefully enhance the experiences of all students whether they study in an Australian or offshore campus.

This article will look into how one university (Swinburne University of Technology) engineering faculty, in its local Australian and offshore campus, is currently preparing engineering graduates to be adaptable for an international and culturally diverse environment. Surveys were carried out to explore students' current perspectives on how they see their profession in the global environment and how

well they feel they are currently being prepared to work in a culturally diverse environment. The results and analysis of the survey is presented in the current article.

Current practices

The following is a list of examples obtained from the Mechanical Engineering discipline at the university that demonstrated ways of the curriculum currently prepares students for local and international environments.

Internationally experienced academic staff

- A high number (approximately 120) of faculty academics (teaching and research) with international work and research experience. They are encouraged to incorporate their own (local and international) professional experience, knowledge and skills into their classroom teaching.

Internationalised content and approaches in learning and teaching

- International standard textbooks, examples, problems and applications are used.
- The content and delivery approaches encourage students to develop an international/global perspective and awareness of the global impact of the engineering profession. The students are exposed to real-life global issues and problems, e.g. growing population, shrinking resources, energy problems, and sustainability issues.
- In group work, class activities, and final year projects, students are encouraged and expected to work in culturally mixed teams. Students are also challenged to consider and address areas that may be out of their cultural experience.
- Visiting international and local professionals (academics and professional engineers) deliver guest lectures providing opportunities for students to be more aware of the diverse working environments of the professional engineer.

Activities that promote inter-cultural engagement and international experiences

- An Elective Plus program is offered providing students with options to broaden their career, i.e. they can undertake study outside their degree discipline under several themes, such as Language Practice and Culture as well as Sustainability.
- Swinburne provides scholarships to students wishing to undertake an international exchange, e.g. studying at universities member of the European Consortium for Innovative Universities (ECIU).
- Industry-Based Learning (IBL) program, where the students can undertake a full time paid placement in industry (local and international) for 6 to 12 months in their area of study.
- The students are made aware of and encouraged to take up international work experience opportunities such as Engineers Without Borders; international IBL and placements with the International Association for the Exchange of Students for Technical Experiences (IASTE).

By encouraging students to gain first-hand experience in an engineering-practice environment locally or internationally, it is hoped that this will build adaptability, competency and improve their awareness of the range of issues associated with professional practice at the local and international level.

Methodology

A study was carried out on undergraduate Mechanical Engineering students enrolled in a Heat Transfer unit to elicit their current perspectives and experiences in working in culturally mixed groups, and also in how they regarded the preparation they were being given for working in a global environment. The Heat Transfer unit is offered in the third year of the program. The majority of the students were from 3rd year cohort, however, students from 2nd year who meet prerequisites and 4th year students (total 10%) were also enrolled in the unit. About 30% of the student had taken the Industry Based Learning thus had been exposed to engineering working experience and might have been exposed to some form of multi-cultural experience in their workplace. The study was carried out in the Hawthorn (Australian) campus with 112 enrolled students of which 87 local students (78%) and 25 (22%) international students (international student in this context refers to student with international student visa). At the same time a parallel study was carried out in the offshore Sarawak campus with twelve students (11 local/Malaysian and 1 international).

Results

The students were asked about their experiences in working in culturally mixed groups, at the university. The results for the Hawthorn and Sarawak students are shown in Table 1. 59% of the local Australian students agreed and 24% were unsure that the university had prepared them to work with people from different cultural backgrounds. 39% of the international students agreed with 50% were unsure. At the Sarawak campus, 89% of the students agreed that the university had prepared them to work with people with different cultural backgrounds with the rest (11%) unsure.

The majority of the Hawthorn students (74% local and 67% for internationals) responded that they were aware on how the engineering profession fits within the global environment. 60% of the local and 67% percent of the international students agreed that they have had learning opportunities that included looking at global problems. About 56% of the Sarawak students were aware of how their profession fits within the global environment; while the rest of them (44%) were unsure. 89% of these students agreed that they had had learning opportunities that included looking at global problems.

At the Hawthorn campus, the majority of local (86%) and international (75%) students responded that they had worked in culturally mixed group projects before; and about 71% of the local and 75% of the international students were quite comfortable working or studying in culturally mixed groups. At the Sarawak campus, about 78% of the students have worked in culturally mixed groups and were comfortable in doing that too.

Table 1: Survey results on students' previous experiences working in culturally mixed groups

The university has prepared me to work with people from different cultural backgrounds				
		Agree	**Unsure**	**Disagree**
Hawthorn	**Local**	59%	24%	17%
	International	33%	50%	17%
		Agree	**Unsure**	**Disagree**
Sarawak		89%	11%	0%
I am aware of how my profession fits within the global environment				
		Agree	**Unsure**	**Disagree**
Hawthorn	**Local**	74%	17%	9%
	International	67%	25%	8%
		Agree	**Unsure**	**Disagree**
Sarawak		56%	44%	0%
I have had learning opportunities that included looking at global problems				
		Agree	**Unsure**	**Disagree**
Hawthorn	**Local**	60%	26%	14%
	International	67%	25%	8%
		Agree	**Unsure**	**Disagree**
Sarawak		89%	0%	11%
In the past I have worked in culturally mixed project group				
		Agree	**Unsure**	**Disagree**
Hawthorn	**Local**	86%	7%	7%
	International	75%	17%	8%
		Agree	**Unsure**	**Disagree**
Sarawak		78%	11%	11%
I have been comfortable working/studying in culturally mixed groups				
		Agree	**Unsure**	**Disagree**
Hawthorn	**Local**	71%	24%	5%
	International	75%	25%	0%
		Agree	**Unsure**	**Disagree**
Sarawak		78%	22%	0%

Table 2 shows the results of the survey on the questions relating to the student perspectives on how comfortable they were in working in mixed groups. In general, the students responded positively to the idea of working in mixed groups. Large number of Hawthorn students (60% local and 75% international) agreed that working in mixed groups was useful for learning new skills. Similar number of students also thought that working in mixed groups was interesting (65% local and 75% international). 78% of the local and 67% of the international students thought that working in mixed group was challenging; and 55% of the local and 58% of the international thought that it was worthwhile. In the Sarawak campus, 89% of the students agreed that working in mixed groups was

useful for learning new skills and it was worthwhile. All the students agreed that working in mixed groups were interesting and challenging.

Table 2: Survey results on students' view on working in culturally-mixed groups

Working in mixed groups were useful for learning new skills				
		Agree	**Unsure**	**Disagree**
Hawthorn	**Local**	60%	20%	20%
	International	75%	17%	8%
Sarawak		**Agree**	**Unsure**	**Disagree**
		89%	11%	0
Working in mixed groups were interesting				
		Agree	**Unsure**	**Disagree**
Hawthorn	**Local**	65%	20%	15%
	International	75%	8%	17%
Sarawak		**Agree**	**Unsure**	**Disagree**
		100%	0	0
Working in mixed groups were challenging				
		Agree	**Unsure**	**Disagree**
Hawthorn	**Local**	78%	12%	10%
	International	67%	25%	8%
Sarawak		**Agree**	**Unsure**	**Disagree**
		100%	0	0
Working in mixed groups were worthwhile				
		Agree	**Unsure**	**Disagree**
Hawthorn	**Local**	55%	30%	15%
	International	58%	34%	8%
Sarawak		**Agree**	**Unsure**	**Disagree**
		89%	11%	0

In general, the responses from students in both campuses were positive and encouraging. The responses from the Sarawak students were found to be more positive than that of from Hawthorn. This may be due to the fact that on the Sarawak campus, only a small number of students were enrolled in the Heat Transfer unit. Overall, the students seemed to recognise the importance of the experience of working in mixed groups. The followings are some of the responses on the open ended questions from the Hawthorn students:

(Local student): *Working in mixed groups or groups of mixed people from different cultures brings a whole new perspective into how we do things. By learning each other cultures we can adapt our ways of thinking to produce the best products that will cater for all cultures*

(International student): *I have learned a lot while working in mixed groups. I think it's very important for international students to work with local students and share their perspective. I feel Lecturers should be more inclined towards organising/formation of groups rather than leaving an individual student*

Despite the positive responses, the students' previous experiences in working in mixed groups, however, were not without problems. The problems usually associated with language barrier, cultural gaps, free riders and other general working-in-groups problems. Some of the students' views are presented below:

(Local student): *Language barriers generally mean much less work gets done. Splitting up responsibility is difficult. English skills of international students in my experience have been terrible. I end up doing more work to ensure the project is of a decent standard. Very hard to organize time to do work - different people with different priorities*

(Local student): *When working in multicultural groups, there are often difficulties with both language and culture. When the groups are forced together, the group often work poorly, and don't communicate; leaving students to choose their own groups is much more beneficial*

(Local student): *There are always people that don't pull their weight. It is unfair when I put in heaps more effort an get the same marks as everyone else. Unfair when people with different standards or quality of work bring my work down. Unless I have hard working and committed members I would rather work by myself.*

(Local student): *It is always initially challenging working in a diverse group because you have to bridge the cultural gaps. After a while it gets easier as you understand each other better and communication improves*

(International student): *Well balanced mixed cultural groups have been worked fine. But when a certain student from some culture dominate group, it wasn't really worked out. It is a little bit uncomfortable when I am the only person from different culture in a group.*

The majority of students responded that they were aware of how the engineering profession fits globally. It also appears that the students understand that for them to be able to work across cultures effectively, they need to be aware of different cultures and practices. There also seems to be some awareness by students that working and studying with other students of different cultural background provide learning opportunities for intercultural awareness. Despite this, from our observations in classes, local and international students prefer studying and working on assignments with students of a similar cultural background. This observation aligns with the work of Volet and Ang (1998) who identified four reasons for non engagement: cultural-emotional connectedness, language, pragmatism, and negative stereotypes.

Where do we want to go from here?

There has been an increase in the numbers of international students coming to Australia over the past decade (Australian Bureau Statistics, 2002; Higher Education Statistics, 2007). In 2007, there were 273,099 international students attending Australian tertiary education, and of these about 20,418 students were studying in the field of Engineering and Related Technologies (Higher Education Statistics, 2007). The high numbers of international students clearly increase the diversity of the student body in universities in Australia. This diversity – which relates to ethnic, religious, socio-economic, political backgrounds, languages spoken, interests, motivations, expectations, prior learning experiences and expectations – provides an environment on campus and in class that can be used to develop intercultural awareness and communication skills. Previous research (Quintrell and Westwood, 1994; Volet and Ang, 1996) indicates that local and international students do not readily engage interculturally and tend to study in parallel throughout their programs. Unless institutions artificially create conditions for inter-cultural engagement as part of the formal study, students would choose to stay within their own cultural groups and miss out on critical learning opportunities (Volet and Ang, 1998). It is up to the institution to provide a safe and meaningful environment to learn to work cross culturally to better prepare them for working with people from a variety of backgrounds.

Development of a pilot project

To improve the student learning on intercultural awareness, the authors are planning to develop a pilot project within the Heat Transfer unit in the mechanical engineering discipline. The newly modified assessment component will utilise a real-world problem as a Group Project on Sustainable Energy.

The class will be divided up into 25 groups (each group consists of 4 or 5 students). The lecturer will form the groups and make sure that each group has at least one international student. The groups will be asked to design a system for delivering electricity for a small village (population of about 200) in two remote areas; one in Australia and one in another country (i.e. the country can be from anywhere, however it is hoped that students may take advantage of the local knowledge of the international student in the group). This is designed to create an environment where the international student member may be seen as an "expert" in the overseas location and may have knowledge that is respected and valued by the group. The group is then expected to research and evaluate the feasibility of one type of sustainable energy to be used for the above purpose. They also have to compare the applications of this energy in the two different locations.

The groups will have to deliver their findings through a group report and a group oral presentation. In the group report they have to discuss the differences in the applications/practices of the chosen energy in Australia and in the other country. The group will need to research the impact of such project on the two chosen locations relating to the following aspects: energy source requirements and availabilities, cultural and social aspects, geographical aspects, economic values, logistics and transportation availabilities, and other important factors. It is hoped that there be some recognition of the international student's "expert knowledge" relating to socio-cultural and environmental aspects and the need to engage interculturally may enrich the whole learning experience of the group.

Some resources will be provided to the students to help them carry out the project and to facilitate the group work. These will include some reading materials on team development as well as lecture on

working in culturally diverse groups to provide some support in bridging the cultural gaps. An online discussion board will also be set up to facilitate online discussion between the students in the group, tutors and lecturer. The tutors and lecturer will also be available for mentoring the groups.

A second survey and focus groups are planned at the completion of the project to explore student perspectives on the experience carrying out the project. The results of the pilot project will be described in a second paper.

Conclusion

Studies were carried out on the mechanical engineering students in the Heat Transfer unit at an Australian and Malaysian campus to explore local and international student perspectives as to how they are prepared to work in a culturally diverse global environment. It appears that generally students' were positive about their previous experiences in working in mixed groups, and learning opportunities that have includes looking at global problems. They also appear to feel that they have been well prepared by the university to work with people from different cultural backgrounds, however, the reality is that many of them tend to choose to work in more homogeneous groups, and thus are not experiencing and developing well developed intercultural communication and work place skills. As a result of this study, a pilot intercultural group project has been proposed to be developed and employed in a Heat Transfer unit. The plan is to artificially create a culturally mixed group work project, embed a modified assessment component that requires the group to draw on the knowledge of a "cultural expert" to create an environment that requires intercultural engagement. It is hoped that students will develop greater awareness of another cultural environment through a real-world problem, and build intercultural understanding and communication skills that will enhance their learning opportunities in preparation for working in a local and international environment.

References

Australian Bureau of Statistics (2002). *Statistics on overseas students in higher education in Australia in 2000, Cat. No. 4230 – Education and Training Indicators*, December 2002. Accessed at http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/4230.02002?OpenDocument on 13 June 2009.

Bradley, A. (2006). Engineers Australia Policy on Accreditation of Professional Engineering Programs, Issued 19 July 2006, The Institution of Engineers Australia. Accessed at http://www.engineersaustralia.org.au/shadomx/apps/fms/fmsdownload.cfm?file_uuid=0B1B282A-EB70-EC35-6B21-BB84E8F0C8E7&siteName=ieaust on 13 June 2009.

Grear, B.J. (2006). The future of global engineering. Sydney Division Fellows Meeting, 10 November 2006, The Institution of Engineers Australia. Accessed at http://www.engineersaustralia.org.au/shadomx/apps/fms/fmsdownload.cfm?file_uuid=E8F3A8C7-FF5D-6B2F-AF25-FE7C80FB35E7&siteName=ieaust on 13 June 2009.

Higher Education Statistics (2007). *Statistics on Commencing and All overseas students (higher education) in Australia in 2007*, Department Education, Employment and Workplace Relations, 2008. Accessed at (http://www.dest.gov.au/sectors/higher_education/publications_resources/profiles/Students_2007_full_year_.htm) on 13 June 2009.

Quintrell, N. and Westwood, M. (1994). The influence of a peer-pairing program on international students' first year experience and use of student services, *Higher Education Research and Development, 13(1),* 49-57.

Swinburne Graduate Attributes and Key Generic Skills. (2009). Swinburne University of Technology. Accessed http://www.swinburne.edu.au/corporate/registrar/ppd/docs/SwinburneGraduateAttributesandKeyGenericSkills.pdf on 13 June 2009.

Swinburne Statement of Direction 2015. (2009), Swinburne University of Technology. Accessed at http://www.swinburne.edu.au/chance/vc/sod2015.html on 13 June 2009.

Volet, S.E. and Ang, G. (1996). A cross cultural study of university students' perceptions of group work, *Paper presented at the Joint Conference of the Australian Association for Research Education (AARE) and the Singapore Educational Research Association (ERA)*, Singapore.

Volet, S.E. and Ang, G. (1998). Culturally mixed groups on international campuses: an opportunity for inter-cultural learning, *Higher Education Research and Development, 17(1),* 5-23.