Gender inclusive curriculum in engineering and construction management

Final Report 2012

Partner institutions and team members:
University of South Australia (lead)
Associate Professor Julie Mills
Associate Professor Judith Gill
Ms Virginia Mehtens
Ms Lee Clark
Ms Jennifer Macdonald

The University of Melbourne
Associate Professor Roger Hadgraft
Ms Valerie Francis

The University of Newcastle
Mr Willy Sher
Associate Professor Anthony Williams

University of Technology, Sydney
Ms Bronwyn Holland
Dr Peter Smith

Report Authors:
Associate Professor Julie Mills
Ms Mary Ayre
Associate Professor Judith Gill

Support for this project has been provided by the Australian Learning and Teaching Council, an initiative of the Australian Government Department of Education, Employment and Workplace Relations. The views expressed in this report do not necessarily reflect the views of the Australian Learning and Teaching Council Ltd or the Australian government.

This work is published under the terms of the Creative Commons Attribution-Noncommercial-ShareAlike 3.0 Australia Licence. Under this Licence you are free to copy, distribute, display and perform the work and to make derivative works.

**Attribution:** You must attribute the work to the original authors and include the following statement: Support for the original work was provided by the Australian Learning and Teaching Council Ltd, an initiative of the Australian Government Department of Education, Employment and Workplace Relations.

**Noncommercial:** You may not use this work for commercial purposes.

**Share Alike.** If you alter, transform, or build on this work, you may distribute the resulting work only under a licence identical to this one.

For any reuse or distribution, you must make clear to others the licence terms of this work.

Any of these conditions can be waived if you get permission from the copyright holder.

To view a copy of this licence, visit [http://creativecommons.org/licenses/by-nc-sa/3.0/au/](http://creativecommons.org/licenses/by-nc-sa/3.0/au/) or send a letter to Creative Commons, 171 Second St, Suite 300, San Francisco, CA 94105, USA.

Requests and inquiries concerning these rights should be sent to learningandteaching@deewr.gov.au

ISBN: 978 1 921916 38 0 [PRINT]
ISBN: 978 921916 39 7 [PDF]
ISBN: 978 921916 40 3 [RTF]

2012
Acknowledgements

Project Team

Project Director: Associate Professor Julie Mills

Project Leaders University of South Australia: Associate Professor Judith Gill and Ms Virginia Mehrtens

Research Assistants: Ms Lee Clark and Ms Jennifer Macdonald

Project Leaders The University of Melbourne: Associate Professor Roger Hadgraft and Ms Valerie Francis

Project Leaders The University of Newcastle: Mr Willy Sher and Associate Professor Anthony Williams

Project Leaders University of Technology, Sydney: Ms Bronwyn Holland and Dr Peter Smith

Project Reference Group

Emeritus Professor Robin King (Chair)
Ms Mary Ayre – University of Glamorgan, Wales
Ms Pamela Roberts – CEDAM, Australian National University
Associate Professor Rick Best – Bond University

Independent Evaluator

Dr Lesley Jolly

Human Ethics Clearance

The research that informs this document was collected from a range of sources. All research involving human participants took place in accordance with international standards for ethical human research. The University of South Australia Human Research Ethics approval number for the project is P128-09.
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAEE</td>
<td>Australasian Association of Engineering Education</td>
</tr>
<tr>
<td>ABS</td>
<td>Australian Bureau of Statistics</td>
</tr>
<tr>
<td>ACED</td>
<td>Australian Council of Engineering Deans</td>
</tr>
<tr>
<td>AIB</td>
<td>Australian Institute of Building</td>
</tr>
<tr>
<td>AIBS</td>
<td>Australian Institute of Building Surveyors</td>
</tr>
<tr>
<td>AIQS</td>
<td>Australian Institute of Quantity Surveyors</td>
</tr>
<tr>
<td>ALTC</td>
<td>Australian Learning &amp; Teaching Council</td>
</tr>
<tr>
<td>APESMA</td>
<td>Association of Professional Engineers, Scientists and Managers of Australia</td>
</tr>
<tr>
<td>ASEE</td>
<td>American Society for Engineering Education</td>
</tr>
<tr>
<td>AUBEA</td>
<td>Australasian Universities Building Education Association</td>
</tr>
<tr>
<td>CIOB</td>
<td>Chartered Institute of Building</td>
</tr>
<tr>
<td>CM</td>
<td>Construction management</td>
</tr>
<tr>
<td>DEEWR</td>
<td>Department of Education, Employment and Workplace Relations</td>
</tr>
<tr>
<td>DEST</td>
<td>Department of Education, Science and Technology (now replaced by DEEWR)</td>
</tr>
<tr>
<td>EA</td>
<td>Engineers Australia</td>
</tr>
<tr>
<td>E&amp;CM</td>
<td>Engineering and construction management</td>
</tr>
<tr>
<td>FTE</td>
<td>Full time equivalent</td>
</tr>
<tr>
<td>GIC</td>
<td>Gender inclusive curriculum</td>
</tr>
<tr>
<td>IEEE</td>
<td>Institute of Electrical and Electronic Engineers</td>
</tr>
<tr>
<td>RICS</td>
<td>Royal Institute of Chartered Surveyors</td>
</tr>
<tr>
<td>STEM</td>
<td>Science, technology, engineering and mathematics</td>
</tr>
</tbody>
</table>

Acronyms for individual universities take their customary forms. The term ‘program’ is used for the course of study leading to an award. The term ‘course’ is normally used for a unit of study, sometimes known as subjects.
# Report Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive summary</td>
<td>1</td>
</tr>
<tr>
<td>1.0 Introduction</td>
<td>3</td>
</tr>
<tr>
<td>2.0 Statistics</td>
<td>7</td>
</tr>
<tr>
<td>3.0 What is a gender inclusive curriculum?</td>
<td>11</td>
</tr>
<tr>
<td>4.0 Benchmarking current perceptions of staff and students</td>
<td>15</td>
</tr>
<tr>
<td>5.0 Education and dissemination</td>
<td>21</td>
</tr>
<tr>
<td>6.0 Accreditation</td>
<td>26</td>
</tr>
<tr>
<td>7.0 Resources</td>
<td>28</td>
</tr>
<tr>
<td>8.0 Conclusions and recommendations</td>
<td>29</td>
</tr>
<tr>
<td>9.0 References</td>
<td>33</td>
</tr>
<tr>
<td>Appendix 1: Benchmarking survey</td>
<td>36</td>
</tr>
<tr>
<td>Appendix 2: Accreditation submission</td>
<td>40</td>
</tr>
<tr>
<td>Appendix 3: Independent evaluation</td>
<td>47</td>
</tr>
</tbody>
</table>
Executive summary

In the current climate of increasing skills shortages in essential industries in Australia, the low rate of enrolment and retention of women in Engineering and Construction Management (E&CM) degrees in Australian universities is well established as a concern for E&CM faculty and for the related professions. These discipline areas and associated degree offerings may be organised differently at different universities, but the curriculum and student body have common issues that the project aimed to address.

The purpose of this project was to bring about sustainable change in the teaching and learning of E&CM in order to encourage the enrolment of a larger number of women, to accommodate the increasingly diverse student body and to improve the retention and success of all students in these areas.

Early in the project, the team engaged in a benchmarking exercise at the four partner institutions, which showed that students and faculty in E&CM areas around the country exhibited similar understandings and misunderstandings regarding the inclusivity of their teaching and learning and the rationale for adopting a more inclusive approach. The benchmarking activity and results are described in Chapter 4.

The education and dissemination activities for the project focused on two main areas: publications and workshops. Two significant publications have been produced during the project. The first and most extensive was the book *Gender Inclusive Engineering Education* written by Julie Mills, Mary Ayre and Judith Gill and published by Routledge in April 2010. The book summarises arguments for increasing the proportion of women in engineering education and employment, and addresses the problems of recruitment and retention of women in this field of study. It advocates gender inclusive curriculum strategies and provides practical examples of their application.

The second significant publication produced during the project was the document *Guidelines for the design of inclusive engineering education programs*. The guidelines summarise some of the key messages and practical strategies that are more extensively described in the book. In addition they provide advice on benchmarking the current position of an engineering program and faculty with regard to its gender inclusivity. It is hoped that the guidelines will be adopted as an approved reference document in the Engineers Australia accreditation procedures. These guidelines were disseminated to all associate deans teaching and learning (or equivalent positions) in engineering faculties in Australia for distribution to academic staff involved in teaching engineering at their institutions. They have also been distributed to relevant construction management accrediting bodies.

A series of half-day workshops were held initially at the University of South Australia (UniSA) followed by similar presentations at each of the partner institutions: The University of Melbourne, University of Technology, Sydney and The University of Newcastle and at the Australasian Universities Building Education Association (AUBEA) conference in Melbourne in 2010. These state-based workshops were used to showcase examples of inclusive curricula at various levels of activity, course and program. They also functioned to build collaboration between E&CM educators interested in curriculum reform. These activities are described more fully in Chapter 5.

---

1 The use of the term E&CM has been adopted throughout this report to cover a broad range of areas including all disciplines of engineering, construction management, quantity surveying and building surveying.
A project website is available to inform people of the progress of the project and to provide a site for ongoing interaction around the area of gender inclusive curriculum. The book and the project website provide print and web-based foundations for the workshops and represent an ongoing source of support for educators seeking to reform and enrich their teaching.

Through these education and dissemination activities the project has sought to increase awareness of gender inclusive curriculum in E&CM staff and students. It is hoped that this increased awareness will lead to changes to the practice of teaching and learning in E&CM in line with inclusive curriculum principles. Within each institution the project sought to ensure the changes to curriculum were of a lasting nature through the provision of advice on ways and means of embedding of inclusive curriculum principles into institutional quality processes for course and program development and approval.

In addition, we sought to ensure that these developments will be sustained by embedding inclusive curriculum principles into the requirements of professional accreditation bodies. The project has had significant input into the review of the current accreditation criteria for Engineers Australia and the development of the Guidelines document as an approved reference document. The outcomes of this review will be finalised in 2011. The ability to influence accreditation processes in construction management has proved problematic due to the wide variety of accrediting bodies, all with differing procedures and requirements. Ultimately though, the objective was a continuing one, namely that the dissemination through practice, embedding via accreditation and institutional endorsement and advocacy of the project outcomes will lead to the transformation of E&CM related professions into more inclusive professional arenas.
1.0 Introduction

The scarcity of women in engineering and construction management

Despite numerous initiatives over the past 30 years, women continue to be a small minority in engineering education and employment, currently about 15 per cent and eight per cent respectively in Australia, the lowest female share of any broad field of education (DEEWR 2010; Engineers Australia 2010). In the last five years across the US, Canada, UK and Australia, the percentage of female enrolments in engineering has declined, as has the total of male enrolments. This confirms that the gender disparity in engineering enrolments is unlikely to diminish without systemic approaches linking recruitment, course design, teaching and learning and the student experience (Mills et al, 2006; Mills, Mehrtens, Smith & Adams 2007; Gill, Mills, Sharp & Franzway, 2005; Gill, Sharp, Mills & Franzway, 2008).

The current figure of nine per cent female undergraduate enrolments in construction management at the University of South Australia appears typical of the seven Australian universities that offer such degrees, and it is estimated that only 7.9 per cent of managers and professionals in the construction industry are women (ABS 2003). The ALTC funded project, Issues and Opportunities Confronting Construction Management Education, and a benchmarking study undertaken at The University of Newcastle have also identified that there is a disproportionately small number of females participating in the sector, as students, teaching academics and in industry.

Retention of students is also a critical issue. In the 2008 ALTC Discipline study report Addressing the supply and quality of Engineering graduates for the new century it was noted that “on average, male Australian engineering students have about 52 per cent likelihood of successful graduation from a bachelor level engineering program, and females about 60 per cent” (King, 2008, p. 39), a situation that clearly requires a re-examination of the current teaching and learning regimes in these areas. The King report also recommended more female-friendly engineering education and workplaces to address these issues and proposes specific action within its recommendation for implementing best-practice engineering education to “define and implement inclusive curriculum for engineering: reducing male stereotypes within the curriculum” (King, 2008, p. 107). Thus the need for curriculum development in this area has already been confirmed as very important by leading engineering educators and the engineering profession. Similar concerns about retention are equally applicable to construction management.

Why does this matter?

Engineering and construction management (E&CM) are professions with a critical role in the sustainable development of modern society. However there is already a shortage of engineers and construction managers in the developed and developing world, and this is expected to worsen, particularly in Australia (DEST, 2006). Even in the context of Australia’s gender-divided workforce, engineering and construction management stand out as professions that have maintained an overwhelming reliance on males to fill their student places. Consequently these fields will face more obstacles to overcoming current and predicted skills shortages than will other professions.

Whilst the skills shortage is certainly a major concern and can function as a key economic driver to address the issue of gender imbalance in E&CM, it is clearly not the only justification for addressing the participation of women in E&CM. Increasing the number of women in E&CM is an issue of social justice as it directly relates to the improved distribution of the benefits accruing to prosperous societies, and to ensuring that a wider range of the citizens of these societies play an active and informed part in the control and use of their resources and assets. If, as we have
argued, engineers and construction managers are responsible for decisions and developments that impact on the daily lives of all members of society, then clearly those decisions will be more representative of the desires and needs of that society if the profile of the professional workforce is also representative of that society. The issue of quality is also crucial, to ensure that the most able people from all backgrounds are provided with the education necessary to contribute to the further development of knowledge.

Why target the undergraduate curriculum in E&CM?

Undergraduate education is the ‘gatekeeper’ for professional careers in E&CM fields and hence it is a critical site for intervention (Davis et al, 1996). Government agencies, industry, and educational institutions have devoted significant resources since the mid 1980s to try to increase the numbers of women enrolling in E&CM degrees, but the gains have been slim. Many of the programs to increase women’s enrolments, while moderately successful, have been short-lived and reliant on short-term funding and the advocacy of project champions. Just a few have provided a platform for leading a strategy for long-term and sustainable change that is embedded in the curriculum. This in no way diminishes the importance of continuing and reinforcing the other components of attraction and retention programs for women (high school outreach, mentoring and support etc.) but it is essential that the curriculum shortcomings are addressed as well.

The curriculum provides students with the knowledge and skills required for entry to the E&CM professions. The selection of these is the responsibility of the academic staff, in conjunction with the national accreditation bodies, and the choices made will therefore shape student perceptions of the current priorities, values, attitudes and practices in the professions. The curriculum will not only be the main influence on students’ learning experiences, it will also provide the foundation for their professional lives, influencing their attitudes to broader cultural change, such the challenge to organisations to invest in diversity and workplace strategies which will attract, retain and assure a career path for women in the professional E&CM workforce.

The notion of E&CM curricula as being gendered or masculine may seem ridiculous or contrary to many who think that these programs are about teaching students an objective body of knowledge and skills. However, curriculum involves choices not only about the knowledge and theories students learn, but also about the language, examples and problems used, the design of teaching and learning activities, the learning environment and modes of delivery and assessment. All of these choices involve assumptions about what distinguishes engineering knowledge, how students learn and what will be interesting and relevant to them.

The conventional undergraduate E&CM curriculum has been identified as typically catering to a narrow range of student interest and prior experience “… students and others have observed that engineering curricula (and physical science texts) tend to be crafted with over-use of masculine stereotypes and examples, such as automobiles, rockets and weapons” (King, 2008, p. 72). Similarly a US National Science Foundation report observes that the engineering curriculum and culture are "at odds with the value systems of most young women and minorities, and ... probably at odds with those of many talented students of any race and gender" (NSF, 2005: 36). At the same time E&CM educators may resist curriculum change because of a conviction that the engineering science knowledge base of their discipline is objective and independent of its social contexts. However current learning theory suggests that all knowledge operates in a social environment such that certain sorts of knowledge become associated with times, places and gender. This project sought to raise awareness about the gendered nature of the curriculum in E&CM and to promote opportunities to make disciplinary knowledge accessible to
a diversity of students by relating it to everyday knowledge and practices.

Project aims
Specifically, this project aimed to:

1. Raise awareness of the need for inclusive curricula in E&CM among academic leaders, program designers, teaching staff and students in these disciplines.
2. Initiate and establish a national monitoring device which publishes regularly the gender-disaggregated statistics on enrolments and graduations in E&CM.
3. Develop and present a theoretical framework for the design and implementation of inclusive curriculum, relating learning theory to practical examples.
4. Collect and develop exemplars of inclusive curriculum content and implementation strategies at program and course level.
5. Disseminate inclusive curriculum resources and strategies to staff in E&CM faculties across Australia using forums, the project website and established online networks.
6. Work with universities to embed inclusivity in graduate outcome statements and course and program approval processes.
7. Combine with relevant industry bodies such as Engineers Australia (EA), Australian Council of Engineering Deans (ACED), Australasian Universities Building Education Association (AUBEA) to ensure that the principles of inclusive curriculum are valued and embedded within accreditation criteria for E&CM programs in Australia.

Intended project outcomes
The intended project outcomes were:

- Increased awareness of inclusive curriculum in E&CM staff and students
- Changes to practice of teaching and learning in E&CM in line with inclusive curriculum
- Closer cooperation between university staff on issues of inclusive curriculum
- The embedding of inclusive curriculum principles into institutional quality processes for course and program development and approval
- The embedding of inclusive curriculum principles into accreditation criteria for E&CM programs with the relevant accrediting bodies
- Improved retention rates of women in E&CM in the longer term

Project approach and methodology
The project utilised a phased approach over two years. The initial focus was on establishing a reference group that would help achieve the project objectives and on developing and documenting a shared understanding of the project aims and processes. Another key early strategy was to initiate communication with key E&CM education, industry and accreditation bodies, and to broadcast the existence of the project to E&CM educators as widely as possible. All of these intentions were realised, with three members of the reference group in particular providing key inputs that were essential to the success of the project:

- Robin King provided invaluable advice and links to key bodies through his dual roles as Chair of the Accreditation Board of Engineers Australia and Executive Officer of the Australian Council of Engineering Deans
- Mary Ayre was a co-author of the book Gender Inclusive Engineering
Gender inclusive curriculum in engineering and construction management 6

Education and the booklet Guidelines for the design of inclusive engineering education programs which were both key education and dissemination outcomes of the project.

- Pam Roberts was a key contributor in the development and delivery of the workshops discussed in Chapter 5.

The second phase of the project involved the benchmarking of inclusive curriculum awareness and perceptions of staff and students at each of the partner universities based on a pilot framework previously trialled at the University of South Australia (adapted from Jost, 2004, reported in Mills, Ayre & Gill, 2008). This is discussed in more detail in Chapter 4 of the report.

Throughout the project the team collected course and program level exemplars of inclusive curriculum practice. This was done through a variety of methods including literature review, input from academic staff attending workshops and forums, as well as direct contact with academic staff known to be active in this area. Some of these exemplars were then detailed in the book, some were summarised on the project website and others in the Guidelines booklet. Some were also used within the workshops. It is intended that the collection of exemplars of gender inclusive curriculum practice in engineering and construction management will continue after the formal project is completed, and the project website will continue to be updated.

Once sufficient exemplars were collected, the education and dissemination phase of the project was expanded via state-based workshops with staff in E&CM at each of the partner institutions as well as in other fora. These are discussed in detail in Chapter 5.

The final phase of the project focussed on strategies to ensure that inclusive curriculum principles are embedded in E&CM education and accreditation as discussed in Chapter 6.
2.0 Statistics

Are there really so few women studying engineering?

Australia

While there are certainly more women in engineering than there used to be in the mid 1980s, the percentage of women entering and completing engineering education in Australia has plateaued for the last decade. Figure 2.1 presents data for students commencing engineering degrees in Australia from 1983 to 2008, showing the percentage of commencing students who are women. Figures are taken from the DEEWR (formerly DEST) databases and hence are for the broad field of “Engineering and Related Technologies” from 2001, previously designated as “Engineering, Surveying” from 1983 to 2000. The data therefore include a small number of students undertaking surveying degrees, but since these numbers are very small and the proportion of women very similar, this does not have a significant influence on the outcome. The data include both undergraduate and postgraduate commencements.

In 2008 the percentage of 16.5 per cent finally surpassed the previous highest of 16.4 per cent in 2001 but these data are slightly misleading due to the higher percentage of women entering postgraduate study. Examining the data for Bachelor degree commencement only shows that this percentage in 2008 was 15.1 per cent, still less than the peak of 15.8 per cent in 2001. In terms of raw numbers of entrants, there were 2133 female students commencing Bachelor degrees in engineering in 2001 and 2377 in 2008 – an almost negligible increase. The next lowest Broad Field of Education in terms of female participation is Architecture and Building, with 41.3 per cent in 2008 although this has also plateaued since 2000. That statistic also masks the low percentage of women in building compared with architecture degrees.

![Commencing Engineering Students 1983-2008](image)

Figure 2.1: Percentage of students commencing engineering degrees in Australia who were women, 1983-2008 (DEEWR 2010)
International

The situation is similar in other English-speaking, western countries. In the USA, women comprised 18.1 per cent of total undergraduate completions in engineering in 2007-8, which was the lowest percentage since 1996 (ASEE 2009). In Canada, female graduation from undergraduate engineering degrees decreased from a peak of 21.8 per cent in 2003 to 18.9 per cent in 2007 (Engineers Canada 2009). The percentage of female graduations in engineering in the UK has not followed this downward trend, steadily increasing to 15.4 per cent in 2007-8 (Kirkup et al 2010), but this is still noticeably lower than other European countries.

There are some countries and regions where the percentage of women graduating with engineering degrees is significantly higher than in English-speaking countries, although nowhere is it in line with the percentage of females in the population, or the percentage of university graduates who are female (refer Mills, Ayre and Gill 2010, Chapter 2 for a range of relevant statistics). The formerly communist countries of Central and Eastern Europe are generally considered to have the highest proportion of female engineers in the world but, as a result of the political and social changes since the disbanding of the Soviet Union, there has been a dramatic decrease in the percentage of women engineering students. For example, in Russia, this percentage has declined from 58 per cent in 1995 to 30 per cent in 2002. Hence it seems likely that the percentage of female engineers graduating across all countries will continue to be in the range of 15 per cent to 30 per cent at best for the near future (Mills, Ayre & Gill, 2010).

Differences between engineering disciplines

A commonly made observation is that there are lots of women in certain fields of engineering such as environmental and chemical, and it is certainly true that they are better represented in these disciplines. However, it should be remembered that those specialisations with higher percentages of females frequently represent a very small percentage of the overall number of engineering degrees awarded, since the traditional disciplines of civil, electrical and mechanical engineering still make up the vast majority. For example in Canada in 2007, chemical and environmental engineering degrees had over 40 per cent women enrolments, but they accounted for only 9.3 per cent of all engineering degrees awarded (men and women). At the same time electrical and mechanical degrees, with low percentages of women, accounted for 70.4 per cent of all engineering degrees (Engineers Canada 2009). The higher rate of participation of women in chemical and environmental engineering certainly confirms that gains may be made through social connectedness of curriculum content, female role models and critical mass of women students. However, unless the larger, more traditional discipline areas can attract more women, there will be little change in the overall rate of female participation.

Retention

Retention and success data in Australia now indicate that women are more likely than men to complete engineering degrees, but the retention rates for both genders have room for improvement. There are a number of difficulties in obtaining true retention rates due to the complications of double degrees, part-time study, transferring students and students who take longer than the standard duration to complete a degree. However, a crude estimation can be made by considering DEEWR completion numbers compared with commencement numbers four years earlier. Table 2.1 provides this comparison for students who commenced engineering Bachelor degrees in 2005 compared with those who completed Bachelor Pass and Bachelor Honours degrees in 2008.
Table 2.1: Indicative retention rates for engineering students (DEEWR, 2010)

<table>
<thead>
<tr>
<th></th>
<th>No. of students commencing Bachelor degrees in Engineering in 2005</th>
<th>No. of students completing Bachelor Pass or Honours degrees in Engineering in 2008</th>
<th>Per cent Retention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>11750</td>
<td>7220</td>
<td>61.4</td>
</tr>
<tr>
<td>Female</td>
<td>1921</td>
<td>1441</td>
<td>75.0</td>
</tr>
<tr>
<td>Total</td>
<td>13671</td>
<td>8661</td>
<td>63.4</td>
</tr>
</tbody>
</table>

Hence these data indicate that the retention rate for women was approximately 14 per cent higher than for men. But they also indicate that 25 per cent of women and nearly 40 per cent of men who commenced engineering degrees did not complete them, so this is certainly a challenge requiring further attention.

It should also be noted that retention data from a range of international sources are contradictory and can vary widely between different institutions in the same country (Ohland et al. 2008). Studies of women in engineering point to the fact that women who enter engineering study often have higher commencing tertiary entrance scores than their male counterparts, and have personal characteristics that include persistence, high expectations and self-confidence (NCES, 2000). Hence it may not be surprising that this self-selected minority within the engineering student cohort persists and succeeds in engineering study (Mills, Ayre and Gill, 2010).

Academic staff

The lack of female peers and role models can be discouraging for female students (Goodman Research Group 2002). The presence of senior and high profile women academic staff in E&CM schools is therefore important not only as role models and mentors, but also to model a diverse community in the professions (NSF 2005). However, the number and percentage of women faculty members in engineering is very low overall, particularly at the level of full professor. In the USA, in 2008, women made up only 12.3 per cent of total tenure track faculty in engineering and only 7.4 per cent of full professors (ASEE 2008). Similarly in Europe, only 5.8 per cent of full professors in engineering were female (European Commission 2006). In addition, US studies indicate that women faculty members earn less, are promoted less frequently to senior academic ranks, and publish less frequently than their male counterparts (NSF 2005). In Australia, in 2008, there were 190 full-time equivalent (FTE) women and 1567 FTE men in teaching-only and teaching/research academic positions in the Engineering and Related Technologies field of education, indicating 10.8 per cent women, up from 8.1 per cent in 2000 (129 women FTE, 1462 FTE men) (Godfrey & King, 2010).

Is the situation any better in construction management?

The 2009 ALTC report Construction education in Australia: a review of learning and teaching challenges and opportunities (Williams et al, 2009) provided statistics on the representation of women in various disciplines of construction. These showed that the number of women had remained stagnant at between 650 and 690 from 2001 to 2006, representing a declining percentage of students overall from 18.4 per cent of total students in 2001, decreasing to 17.2 per cent in 2006.
In terms of the particular specialisations within construction, the data showed that the gender distribution was 17.3 per cent female for construction management, 17.8 per cent female for quantity surveying and 16.2 per cent female for building surveying in 2006 (Williams et al 2009, p. 88-90).

The Williams et al report also noted that there were 21 female staff teaching in construction management across Australia in 2008 (i.e. 19.6 per cent of the total staff complement), but showed that 75 per cent of these were employed at lecturer/assistant lecturer level (Williams et al, p. 21 and 62).

Hence the situation in construction management is only marginally better than that in engineering in Australia and both areas will need to employ similar strategies if this is to improve.
3.0 What is a gender inclusive curriculum?

What is curriculum?
Throughout this project, and in accordance with current usage, the term curriculum is used to describe the whole teaching and learning content, process, and environment. Since the curriculum thus defines and determines not only a student’s learning goals, but also the means of achieving them, it follows that a curriculum must be based on sound learning theory.

Learning theory
Constructivism has become the dominant learning paradigm in recent times (Richardson, 2003; Schunk, 2008). In the constructivist perspective learners are engaged in an active process, and all new learning constitutes a process of building on earlier knowledge. There is no one ‘best’ way to learn: a student who is more used to certain learning strategies from their prior experience, or more naturally inclined to particular learning methods, should have opportunities to employ these preferred learning strategies as well as to be introduced to new ones. Thus, since a student’s prior knowledge and experiences will influence their learning, it is important that in the planning and implementation of the curriculum, attention is paid to the socio-economic and cultural backgrounds of the students. In a constructivist model teachers are expected to reflect on their teaching and to identify approaches that are shown to be productive of student engagement along with those that are not. Thus a constructivist approach implies that teachers are more critically aware of the multiple factors that impact on student learning in any classroom. For present purposes the centrally important idea is that all students should be actively engaged in the learning process – the hallmark of inclusive teaching and learning.

Gender and the curriculum
Elaborating on the broad definition given above, the curriculum includes:
- assumptions about the prior experiences and interests of the students
- the content of teaching (sometimes called the syllabus)
- the teaching and learning methods used
- management of the classroom environment
- the ways in which students are assessed

A constructivist understanding of learning requires an awareness of how gender, as one dimension of the socio-cultural environment of teaching and learning, may affect learning, and should therefore be factored into curriculum design and implementation. The greater the diversity of the student group, the greater will be the diversity of their backgrounds, needs, perspectives and ambitions. A program or course should be designed to give all the students who have been admitted to the class a fair chance of succeeding. In addition, the different perspectives, attitudes and values brought by the minority students can be incorporated into the curriculum to extend, challenge and ultimately improve the thinking of the dominant group. Research has shown however, that in E&CM education, largely because of the homogenous nature of the predominantly male staff and student populations, male interests and perspectives tend to strongly influence the ways in which specific knowledge is taught, and that male styles of interaction dominate (Beder 1989; Lewis 1995; Burrowes, 2001; Goodman Research Group 2002).

Gender is important from a teaching and learning perspective because gender forms part of the taken-for-granted assumptions unconsciously transmitted in every social interaction. Research has shown that when such assumptions become part of the teaching and learning process they can negatively affect those who are made to feel outsiders. ‘Outsiders’ in E&CM may include women and others who are not
mainstream students, who are less able to accommodate the material to be learned, who are less able to speak out in class and who are less likely to score high marks in examinations. Because of the ordinariness of gendered thinking, even the students themselves may be unaware of such discriminating processes beyond a general sense of feeling ‘not right’ in a particular class and not able to perform at their best level. Thus, with the presence of female students a revised approach to the curriculum is needed to ensure their progress and success along with their male counterparts. A curriculum which aims to do this is known as an inclusive curriculum.

A gender inclusive curriculum

A gender inclusive curriculum is a curriculum which has been consciously designed not only to recognise and respond to the differences between individual students, but also to use these differences to enrich the learning experience of all students. A gender inclusive curriculum builds a sense of men and women working together. The curriculum content and the teaching and assessment methods employed should therefore acknowledge the interests, attitudes and perspectives of the non-dominant groups in the classroom, as well as the dominant ones.

The need for curriculum development in E&CM has been confirmed as very important by leading educators and the professions. A recent report on engineering education in Australia recommended more female-friendly engineering education and workplaces and proposed specific action within its recommendation for implementing best-practice engineering education to “define and implement inclusive curriculum for engineering: reducing male stereotypes within the curriculum” (King, 2008, p. 107).

The principles of a gender inclusive curriculum are usually understood to be:
- respect and concern for every student as an individual
- recognising that students are simultaneously individuals and group members and their groups may be differently positioned with respect to knowledge
- commitment to enabling each student to realise his or her full potential
- awareness that differences exist between individual students in interests, values, perspectives, prior experiences, ambitions, learning styles and home circumstances
- commitment to acknowledging, recognising, respecting and accommodating these differences in all components of the curriculum
- using, in a professional way, the diversities which exist amongst students, to enhance the learning experiences of all students
- awareness of, and willingness to address, unstated and maybe unconscious, attitudes, values, assumptions as academic staff which impact on students’ learning environments
- awareness of student-student interactions in class and a commitment to influencing these if they impact negatively on any of the other principles
- listening to students’ comments and evaluations of the informal learning environment as well as the formal parts of the course, and taking these into account in reviewing the curriculum (Mills, Ayre & Gill, 2010, p.13-14)

Thus the concept of a gender inclusive curriculum encompasses a spectrum of strategies and philosophies which, put very simply, will start with the relatively straightforward task of ensuring that there is no sexist behaviour in the class. A variety of teaching and learning methods will be used and the course content will include social and emancipatory elements as well as technical matter.

Incorporating any of these principles in teaching and learning will improve the gender inclusivity of a course or program. Ideally all of them should be incorporated. To be fully inclusive, a curriculum will be inclusive in all its components. However,
the extent to which individual lecturers can change or influence these curriculum components varies according to their position in the academic hierarchy. Every lecturer has responsibility for control of the classroom environment, subject perhaps to general guidelines. Teaching and assessment methods are specified in outline in the course approval documents, but again every lecturer has considerable discretion about how these are interpreted and applied in the classroom or laboratory. The course aims and objectives and most of the content are however determined at a more senior level and the classroom lecturer must adhere strictly to these as set out in the course documents, although individual lecturers are usually able to choose the examples and applications used. Significant changes to some components can only be made through formal processes, needing approval from course and department managers and, in E&CM, usually from the profession too, through accreditation processes.

Thus while an individual lecturer cannot aim to make the whole curriculum inclusive unless involved in the course design, s/he can make it more inclusive in ways suggested below.

Gender inclusive classroom management

The reasons that many women feel uncomfortable in E&CM education are often summarised as the ‘chilly climate’ (Hall and Sandler, 1982). Foremost in this category is sexism in the classroom or laboratory. While most lecturers would not tolerate sexist comments or jokes, they are not necessarily aware of other sexist manifestations, such as male lecturers struggling to relate to female students, or the higher visibility of female students resulting in unwelcome ‘spotlighting’: being singled out for additional help for example (Powell et al, 2007; McLoughlin, 2005). It has also been shown that male students often seize and use the equipment in practical sessions, while the female students merely observe and record the results (Cooney, 1991; Butler-Kahle et al, 1993). Likewise, males speak up in science classrooms more than females and as a consequence receive the most attention from teachers, despite the teachers believing that they give equal attention to both males and females (Rosser and Kelly, 1994). Teacher awareness and attention to these issues by making sure that all students are included and actively participating in the class activities are important because unhappy, uncomfortable or ‘excluded’ students will not achieve as well as they might in a more supportive environment (Chetcuti, 2009).

Gender inclusive teaching and learning

The effectiveness of teaching and learning methods may be moderated by personal characteristics and expectations of both the teachers and the learners. As indicated above, when classrooms become more diverse with the addition of women and students of other ethnic origins, the teaching and learning methods used must become more varied, otherwise the original group will remain dominant and privileged. Firstly, it is important to ensure that the language and materials used in E&CM education do not assume or imply that E&CM is a masculine activity or profession (Riley, 2008). Secondly, particularly when teaching first years, it is necessary to be aware that students from diverse backgrounds are likely to approach their learning in different ways. Thirdly, introducing students to the different attitudes, points of view and priorities of different social and cultural groups towards science, engineering and construction management issues improves the quality of education for all groups by encouraging debate and analysis. Using a range of teaching and learning methods, such as problem-based learning, case studies, collaborative learning and open-ended laboratory investigations, rather than simply ‘chalk and talk’ provides the opportunities to meet all of these objectives.
Gender inclusive curriculum content

The curriculum content can be made more inclusive by using applications and illustrations which span a wide range of experiences and interests, by giving students opportunities to investigate the social and humanitarian aspects of engineering and construction as well as the technical contexts, and even by encouraging students to question who benefits from scientific and technological discovery and who may be excluded from it (Rosser, 1995; Phipps, 2008; Riley, 2008). Also recommended is discussion of issues faced by women engineers and construction managers in the professional workforce, to encourage students to reflect on how gender issues also permeate engineering and construction and how this might affect their future careers (Gill et al, 2008).

How effective is an inclusive curriculum?

The benefits of a gender inclusive curriculum in E&CM extend beyond providing a better learning experience for women students in a predominantly male environment. An inclusive curriculum is constantly reviewed to ensure that all learning experiences encourage and facilitate the full participation of women. Possible consequences of a non-gender inclusive curriculum are that female students are either disadvantaged, or discouraged and demotivated, and either leave E&CM programs or fail to achieve the success to which they have aspired. The efficacy of an inclusive curriculum in achieving these aims has been explored by many academics who have practised it, finding that not only were inclusive curricula preferred by women and other minority students, thus improving engagement and motivation, but also their retention and success rates. Moreover, male students too preferred this teaching approach, and their retention and success rates also improved (Kramer-Kohler et al. 1995; Fromm, 2003; Froyd and Ohland, 2005; for example).

In summary, an inclusive curriculum applies the understanding that learning is more effective by including the different perspectives, objectives and experiences which can be contributed by students from diverse backgrounds. Making EC&M curricula more gender inclusive should not be regarded as a process of remediation but rather as a way of better engaging all students. Unfortunately the current situation is that there has been little change in most institutions in the way that the gender dimension has affected the tertiary curriculum, despite the research which has established its value (Bagilhole and Goode 1998). This project addressed this neglect by providing an accessible theoretical framework for a gender inclusive curriculum and practical guidelines for its implementation.
4.0 Benchmarking current perceptions of staff and students

Introduction
An important early phase of the project was an investigation of the ways in which current engineering and construction management academic staff and students view their current curriculum in terms of its gender inclusivity. Our focus questions were as follows:

- What are the perceptions of E&CM academic staff members about the gender inclusivity of their current teaching practice and learning environment?
- Do the perceptions of E&CM students differ from those of engineering faculty and in what way?
- What are the implications of these findings for improving the awareness and implementation of gender inclusive curriculum practices in E&CM education?

To address the first two questions we surveyed students and academic staff at the partner universities in the project. This followed on from an earlier project where a similar survey had been administered at three universities—one in Australia, one in the USA and one in the UK (Mills & Gill, 2009).

Study methodology
An anonymous online survey was developed for academic staff members and students. The first section of the survey gathered base data from the respondent regarding gender, age, engineering or construction management discipline area or degree, whether English was their first language and which year of their degree they were completing if they were a student. The remaining questions were based on a document previously developed at The University of Newcastle *Benchmarks for cultural change in engineering education* (Jost, 2004).

Respondents were asked to indicate at which level (from 1 to 5) they perceived that their program or course operated, across a range of aspects related to inclusive education. In all cases level 1 was at the lowest level and level 5 the highest. A description of levels 1, 3 and 5 was provided for each question to assist respondents. Only one question explicitly mentioned gender; the remainder were more general but taken together create a picture of the inclusivity of the culture of the program. An example question with level descriptors was:

Question 5: How is theory, or fundamental or contextual information taught within your course(s)?
- Level 1 – Theory is taught largely in isolation
- Level 2
- Level 3 – It is presented in terms of specific industry-related problems
- Level 4
- Level 5 – Social effects are considered and debated wherever possible.

The remaining questions in the student survey were (without level descriptors):
- What kinds of problems are used in your program?
- Are problems approached in a multidisciplinary manner (e.g. do they draw upon or link to a range of other academic areas, such as architecture or other engineering disciplines)?
- How are non-technical professional skills such as communication, team work, project management, organisational skills incorporated into your program?
- What is the basis of assessment in your program?
• Is it assumed that you already have some informal knowledge before commencing your program (e.g. is it assumed that you know how a car engine works or you are familiar with computer spreadsheet software)?
• Is prior knowledge of laboratories and equipment used assumed in your program?
• How are women’s interests, experiences and achievements represented within your program?
• A learning environment includes all aspects of physical and social spaces experienced by students in their study. How would you describe the learning environment you have experienced?
• Discrimination may be defined as not receiving equal access to opportunity, based on characteristics such as gender, race, age, disability, marital status or pregnancy, for example. Sexual harassment may be defined as any unwanted sexual advances or unwelcome conduct of a sexual nature. How are discrimination and harassment dealt with in your program?
• Have you experienced inappropriate language (e.g. racist or sexist), humour or images in your program?
• Gender inclusive education is one that treats men and women equally, is equally available to males and females and avoids any suggestion of either men or women being ‘naturally’ good at particular forms of learning. Is there any comment you would like to make regarding your experience of gender inclusive education during your study at NAME OF INSTITUTION? For example, you may like to provide an example of good practice or bad practice you have experienced in this area, or expand on one of your responses above.

The questions for academic staff were very similar but slightly adjusted to the context of their teaching experience. An example staff survey, with all of the benchmark level descriptors, is included as Appendix 1.

The invitation to participate in the survey including the hyperlink to the survey instrument was emailed to E&CM undergraduate students and academic staff involved in undergraduate teaching at each of the project partner institutions. However, due to the different administrative systems at each institution and differing access of the project team members to email distribution lists for staff and students, the sample number and response rates varied markedly. At one institution, no usable survey responses were received. For this reason it was not possible to draw any conclusions about institutional differences in responses, hence all findings have been aggregated across the three project partner institutions where responses were received.

Findings

Survey response numbers are summarised in Table 4.1.

<table>
<thead>
<tr>
<th>Table 4.1: Benchmarking survey respondent numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discipline area</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Construction management</td>
</tr>
<tr>
<td>Engineering</td>
</tr>
</tbody>
</table>

Responses were received from all E&CM discipline areas at each institution for both female and male students and academic staff. However, due to the small sample numbers in the separate disciplines and the differing disciplines taught at the individual institutions, no attempt was made to compare responses from the various discipline areas or from the same disciplines across different institutions.
A comparison of academic staff and student perceptions on the range of aspects of inclusive curriculum has been summarised in Table 4.2 for Engineering and 4.3 for construction management. The comparison has been made using the average ‘level of inclusivity’ perceived by each group to the various questions. As illustrated in the sample question detailed above, the higher the level number, the closer that aspect of the curriculum or environment is to the ideal for an inclusive curriculum.

Table 4.2: Benchmark levels perceived by faculty and students in engineering on aspects of inclusive curriculum (Level 5 = highest)

<table>
<thead>
<tr>
<th>Aspect of inclusive curriculum</th>
<th>Level perceived by academic staff</th>
<th>Level perceived by students</th>
</tr>
</thead>
<tbody>
<tr>
<td>How is theory taught?</td>
<td>3.4</td>
<td>2.7</td>
</tr>
<tr>
<td>What kinds of problems are used?</td>
<td>3.4</td>
<td>2.8</td>
</tr>
<tr>
<td>Are problems approached in a multidisciplinary manner?</td>
<td>3.5</td>
<td>2.9</td>
</tr>
<tr>
<td>How are non-technical professional skills incorporated?</td>
<td>3.6</td>
<td>3.1</td>
</tr>
<tr>
<td>What is the basis of assessment?</td>
<td>3.4</td>
<td>2.9</td>
</tr>
<tr>
<td>Is informal knowledge assumed?</td>
<td>2.7</td>
<td>2.7</td>
</tr>
<tr>
<td>Is prior knowledge of laboratories and equipment used assumed?</td>
<td>3.1</td>
<td>3.1</td>
</tr>
<tr>
<td>How are women’s interests represented?</td>
<td>2.1</td>
<td>2.5</td>
</tr>
<tr>
<td>How would you describe the learning environment?</td>
<td>3.0</td>
<td>3.1</td>
</tr>
<tr>
<td>How are discrimination and harassment dealt with if they occur?</td>
<td>4.3</td>
<td>3.9</td>
</tr>
<tr>
<td>Have you experienced inappropriate language and images being used?</td>
<td>4.1</td>
<td>3.7</td>
</tr>
<tr>
<td>Average over all aspects</td>
<td>3.3</td>
<td>3.0</td>
</tr>
<tr>
<td>Sample size</td>
<td>N = 16</td>
<td>N = 207</td>
</tr>
</tbody>
</table>

Table 4.2: Benchmark levels perceived by faculty and students in construction management on aspects of inclusive curriculum (Level 5 = highest)

<table>
<thead>
<tr>
<th>Aspect of inclusive curriculum</th>
<th>Level perceived by academic staff</th>
<th>Level perceived by students</th>
</tr>
</thead>
<tbody>
<tr>
<td>How is theory taught?</td>
<td>2.9</td>
<td>3.1</td>
</tr>
<tr>
<td>What kinds of problems are used?</td>
<td>3.5</td>
<td>3.5</td>
</tr>
<tr>
<td>Are problems approached in a multidisciplinary manner?</td>
<td>3.5</td>
<td>3.4</td>
</tr>
<tr>
<td>How are non-technical professional skills incorporated?</td>
<td>3.4</td>
<td>3.6</td>
</tr>
<tr>
<td>What is the basis of assessment?</td>
<td>3.8</td>
<td>3.6</td>
</tr>
<tr>
<td>Is informal knowledge assumed?</td>
<td>2.2</td>
<td>2.8</td>
</tr>
<tr>
<td>Is prior knowledge of laboratories and equipment used assumed?</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>How are women’s interests represented?</td>
<td>1.8</td>
<td>2.4</td>
</tr>
<tr>
<td>How would you describe the learning environment?</td>
<td>3.0</td>
<td>3.2</td>
</tr>
<tr>
<td>How are discrimination and harassment dealt with if they occur?</td>
<td>4.2</td>
<td>3.7</td>
</tr>
<tr>
<td>Have you experienced inappropriate language and images being used?</td>
<td>3.7</td>
<td>3.7</td>
</tr>
<tr>
<td>Average over all aspects</td>
<td>3.2</td>
<td>3.3</td>
</tr>
<tr>
<td>Sample size</td>
<td>N = 13</td>
<td>N = 115</td>
</tr>
</tbody>
</table>
While the responses to the survey have been presented as average scores in Tables 4.2 and 4.3 these results should not be interpreted as firm measures but rather as indicators of opinion sets held by students and staff.

Twenty-nine per cent of the students in engineering and 25 per cent of the engineering staff responded that English was not their first language. Eighteen per cent of the students in construction management and 23 per cent of the construction management staff responded that English was not their first language.

**Discussion**

Interestingly, in all but two areas, engineering staff perceived that their practice was more or as inclusive than students perceived to be the case for their program. It should be recognised that academic staff were responding with respect to their own teaching practices or environments, whereas students were responding on the basis of their overall program. Hence it could be that the faculty who responded to the survey were those who were ‘converted’ to the idea of an inclusive curriculum and did put more of these aspects into practice in the courses they taught. The greatest perception gaps between staff and students (0.6 to 0.7) were related to how theory is taught, the type of problems used and their multidisciplinarity. All of these areas can be quite easily made more gender inclusive by adopting the recommendations that have been made elsewhere in this report and in the resource materials produced during the project. Overall the average perceptions of engineering staff showed that they believed their practice was marginally more inclusive than the students perceived it to be.

The results in construction management were slightly different. The overall average perceptions of CM staff were only marginally lower than those of engineering staff. But, possibly surprisingly, CM students perceived that the practice in their programs was slightly more inclusive than did the staff in CM, and also more than the students in engineering. There was a much greater variation in response between staff and students across the range of questions in CM compared with engineering, even though the average overall was quite similar. The greatest perception gaps between staff and students in CM (0.6) were quite different from those in engineering and related to informal knowledge and the representation of women’s interests. These two questions had the lowest perceived levels of inclusivity for both staff and students in both engineering and construction management and hence deserve particular attention for remediation.

One positive result from the survey was that the overall response from both academic staff and students at all institutions with respect to the questions about discrimination and harassment and the use of inclusive language were amongst the highest ratings. A level 3 response to this question stated that “Some attempt is made to address discrimination and harassment in the teaching and learning environment but it is not consistent across all courses” whilst level 5 stated that “The prevention of discrimination and harassment is consistent across all courses in the program. Inappropriate behaviour is dealt with. Policy is reinforced to students by staff.” This may be a pleasing indication that years of equal opportunity policy implementation and training at higher education institutions may be bearing some fruit. However, it was notable that text responses asserting no discrimination or inappropriate behaviour primarily came from male students:

*All students have been treated equally, whether male or female, without exception during my studies* (male student, electrical engineering).

Whereas a female student noted that:

*A lecturer once made a joke about females that made the class laugh, except me the only female in the class* (female student, mechanical engineering).
Female students also have to cope with perceptions by several male students in their program that they are subject to different standards of support and grading, typified by:

*The number of women in my course is very small under 5, but it seems they receive much more help than others, and easier grading [sic]* (male student, electrical engineering).

*Females in many cases seem to have a golden brick road created for them. There are all levels of extra scholarships and extra attention paid to their needs (not female specific needs, just generic needs)* (male student, mechatronic engineering).

The question of women’s interests being represented in E&CM education was one about which the academic staff appeared even more dubious than the students, although the perceived levels were low in all cases. Without more information, it is difficult to know what may have caused this discrepancy. Could it be that E&CM staff acknowledge a sense of not doing enough to include women’s interests in their teaching? What do they understand by ‘women’s interests’? However, it was notable in the text responses from several staff members that the existence of gender in engineering in particular was denied in favour of the neutrality of technical content:

*Women's issues don't come into systems engineering (nor do men's issues) so it is hard to answer something so hypothetical. Are we supposed to highlight women as being something special* (male academic staff, electrical engineering).

*In most of my subjects, the content is mostly technical and, as far as I am concerned, each student's ability and performance in the subjects and each student's understanding of and competence in the subject material is unrelated to his/her gender* (male academic staff, civil engineering).

*I would expect that a modern approach to curriculum development and delivery would be completely agnostic to gender of the student body. I can't see why gender should be a consideration in any of the technologies, concepts, learning processes, etc. - students should be considered "students" and efforts and energies should be directed at ensuring that the students as a whole are encouraged to participate, contribute and enjoy their learning - gender shouldn't be a distraction* (male academic staff, electrical engineering).

One student respondent was quite hostile to the concept of women’s interests or the idea of being made to think about them at all:

*Been [sic] sexist goes both ways whos [sic] catering for the men, stop trying to force feelings on us* (male student, civil engineering).

The difference between teacher and student perceptions reflected in the benchmark survey results is a common finding in educational research. The important consequence here is to promote awareness by academic staff of the need to consider student perceptions as part of ongoing teaching practice. This is particularly important with respect to the students’ sense of belonging. This result also signals the need for staff to model inclusivity in their practice as well as in the stated goals for their courses.

The overall conclusion we take from these findings is that the survey did provoke academic staff and students to think about their teaching and learning and hence to become a little more self-conscious in these areas. Certainly several staff and
students noted that the small number of women in engineering caused a chicken-and-egg conundrum for their teaching and learning experience:

After all, 'Women’s interests, experiences and achievements' are unlikely to be represented in a class when there aren't any women in the class (male student, electrical engineering).

However, the fact that the survey encouraged both staff and students to consider inclusive aspects of their E&CM education experience is a favourable outcome insofar as it is highly consistent with constructivist learning principles which equip teachers and learners to become more self-reflexive.
5.0 Education and dissemination

Education and dissemination framework and strategies

One of the key reasons for the selection of the partner institutions and team members in this project, was that their involvement from an early stage represented a crucial first step in dissemination and adoption of program outcomes. The majority of the project team and reference group had/have close links and/or leadership roles within education associations and accreditation bodies in the relevant disciplines so this facilitated both dissemination and embedding of the project developments. Dissemination focussed on encouraging E&CM academics to use the principles of the project exemplars in classroom situations and to make curriculum changes to their courses. Two broad approaches to dissemination were used. These were classified as Information Provision and Engaged Strategies.

Information provision

This approach essentially involved the distribution of information in written form to universities, professional bodies and accrediting authorities. Distribution procedures included a book, website, a guidelines booklet, conference papers and formal reports. Several newspaper and professional magazine articles were also published to raise awareness of the project in the early stages. Though routine and traditional, this form of dissemination was nevertheless effective. The dissemination took advantage of the ready access to existing networks of academics in the E&CM areas in which project team members were already involved for example ACED, AAEE and AUBEA.

Book: gender inclusive engineering education

The completion of the book Gender Inclusive Engineering Education by Mills, J. E., Ayre, M. E. and Gill, J., published by Routledge in April 2010, was a major outcome of the project. A copy was distributed to each associate dean teaching and learning for engineering (or equivalent position) at every university in Australia with an engineering program. By 30 June 2010 more than 70 copies had been sold internationally.

The book contains chapters on each of the following areas:

- Current statistics on gender profiles of engineering students, faculty and professionals
- Current learning theories and their application in engineering, including issues of self concept and identity for students in non-traditional areas
- Design of a gender inclusive curriculum in engineering
- Practical examples of gender inclusive curriculum in engineering
- Advice on embedding gender inclusive curriculum in institutional and professional accreditation contexts

Website: gender inclusive curriculum

The website has been continually developed throughout the project and now includes the following sections:

- Welcome
- What do we mean by "Gender Inclusive Curriculum?"
- Why do we need gender inclusive curricula?
- Does a gender inclusive curriculum make a difference?
- What can I do to make my course more gender inclusive?
- Examples of Gender Inclusive Curricula
It is intended that additional examples of gender inclusive curricula will be uploaded to the website after the project completion whenever they are received or collected.

**Booklet: guidelines for the design of inclusive engineering education programs**

The booklet *Guidelines for the design of inclusive engineering education programs* by Mills, J, E Ayre, M. E, & Gill, J. (2010) was developed as an easy reference guide to assist academics to develop inclusive courses and programs. It summarises the principles for designing inclusive curricula, which are detailed in the book. It also provides information to enable engineering faculties to benchmark the current status of their engineering programs with respect to inclusivity.

The booklet was specifically developed with the intention that it be listed as an approved reference document for Engineers Australia accreditation after the current review of accreditation guidelines is completed in early 2011. Hence a copy of the document was sent to Alan Bradley, Engineers Australia accreditation centre as part of the project’s submission to the accreditation review (refer Appendix 2). Multiple copies of this document were distributed in hard copy to the engineering associate deans of teaching and learning in late 2010, as well as all project team members, for distribution to relevant engineering and building academic staff. It is also available as a PDF document from the project website. It is believed that the guidelines booklet should be equally valuable to construction management accreditation bodies to inform their thoughts on inclusive curriculum. Accordingly, a copy has been sent to each of the relevant bodies. Refer to Chapter 6 for further discussion.

**Engaged strategies**

This approach was based on being active and taking the project to academics. It was an extension of distributing information in the written form and its primary aim was to promote acceptance and adoption of the project outcomes at other institutions. Essentially it was about enabling others and promoting awareness through practical activity. Stakeholders were identified as university schools offering E&CM degree programs. The dissemination initiatives that were implemented are described below.

**Workshops**

A series of workshops was held at a range of institutions and conferences during the project period. These are summarised in Table 5.1 below.

The initial intention was that the workshops would raise awareness of the project, explain the concepts behind gender inclusive curriculum and then assist academic staff to review one of their own courses and think about ways in which they could make it more inclusive. It was also hoped that the project team could use the workshops as a means of gathering additional exemplars of good practice that could be added to the website and other resources. A pilot workshop had been conducted along these lines at the December 2007 Australasian Association of Engineering Education (AAEE) conference and was successful in achieving these goals.

The first workshop conducted as part of the ALTC project was at the Australasian
Building Educators Association (AUBEA) conference in July 2009. Although the same format and materials were used as had been the case at the 2007 AAEE conference, it became very clear that the same outcomes were not achieved. There were approximately 30 participants from 14 universities and two professional accrediting bodies in attendance. However, it was clear that the assumptions about prior knowledge of curriculum and gender issues were not appropriate to this group and that the workshop format and content needed to be revised.

Table 5.1: Project workshops 2009-10

<table>
<thead>
<tr>
<th>Date/s of the event</th>
<th>Event title, duration and location</th>
<th>Number of participants</th>
<th>Number of higher education or other institutions represented</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 July 2009</td>
<td>Gender inclusive curriculum 2 hours AUBEA conference, Barossa Valley, SA</td>
<td>25-30</td>
<td>16</td>
</tr>
<tr>
<td>18 Feb 2010</td>
<td>What’s gender got to do with it?: A guide to gender inclusive curriculum for engineers and construction managers Half day University of South Australia, Adelaide, SA</td>
<td>15</td>
<td>2</td>
</tr>
<tr>
<td>15 April 2010</td>
<td>Improving your Course &amp; Delivery: Gender Inclusive Strategies Workshop 2 hours The University of Newcastle, NSW</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>16 April 2010</td>
<td>Improve Your Subject &amp; Delivery: Gender Inclusive Strategies Workshop 2 hours University of Technology, Sydney, NSW</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>16 July 2010</td>
<td>What’s gender got to do with it? 2 hours 2010 AUBEA conference, Melbourne, Vic</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>16 July 2010</td>
<td>What’s gender got to do with it? 2 hours The University of Melbourne, Melbourne, Vic</td>
<td>8</td>
<td>4</td>
</tr>
</tbody>
</table>

The workshop format and content were then significantly revised and an academic experienced in working with academics in the higher education curriculum area was engaged as the main workshop presenter for all remaining workshops (Ms Pam Roberts, Convenor of the Master of Higher Education at Australian National University). A half-day workshop was trialled at the University of South Australia in February 2010.

The focus of the workshops was to assist academic staff in engineering and construction management to develop inclusive curriculum in their courses by exploring the following:

- What is learning?
- What does gender have to do with the engineering and construction management curriculum?
- Case studies of inclusive practice in engineering and construction management
- How can I make my courses more inclusive?
Evaluation of the value and success of workshops

Evaluations were conducted after each workshop at the partner institutions (but not for the conference workshops) and the results of these are presented in Table 5.2. Attendees were asked to rate their responses to a series of statements on the following scale:

- to a considerable extent: 1
- to a moderate extent: 2
- to a slight extent: 3
- not at all: 4

Table 5.2: Evaluations of workshops conducted at partner institutions in 2010

<table>
<thead>
<tr>
<th>Evaluation question</th>
<th>Average response</th>
</tr>
</thead>
<tbody>
<tr>
<td>The workshop:</td>
<td></td>
</tr>
<tr>
<td>(a) helped clarify my understandings of the impact of curriculum on learning</td>
<td>1.6</td>
</tr>
<tr>
<td>(b) helped clarify how gender figures in curriculum</td>
<td>1.6</td>
</tr>
<tr>
<td>(c) provided useful examples of inclusive approaches to curriculum</td>
<td>1.6</td>
</tr>
<tr>
<td>(d) motivated me to introduce inclusive principles to curriculum</td>
<td>1.5</td>
</tr>
<tr>
<td>(e) gave me strategies for introducing inclusivity in curriculum</td>
<td>1.6</td>
</tr>
</tbody>
</table>

(Overall attendance = 28, no. of responses received = 18)

In addition to E&CM teaching academics, the participants at workshops included senior academics such as PVC’s, deans and associate deans teaching and learning, indicating high level support for the initiative and an interest in addressing gender issues in E&CM. Other participants included staff from marketing units, teaching and learning centres and equity/diversity units. The evaluations by participants indicate that the workshops were considered successful in clarifying understandings about gender and providing the motivation and strategies for introducing inclusivity for academic staff who attended. Unfortunately, they attracted low numbers of attendees. This is likely to be due to the pressure felt by academics in many institutions to prioritise research over teaching, which impacts on attendance at teaching development workshops. Workshops were more effective where there was an enthusiastic local person to organise the publicity and venue, and crucially to engage their colleagues with the project. It was also important to have printed resources to leave with participants to provoke further thinking and engagement was also clearly demonstrated.

One of the most critical findings from the workshop was that the project team may have underestimated the readiness of faculty to engage with notions of curriculum. At the first workshop, one participant said the word ‘curriculum’ was not one he had ever used, and his understanding of it was as a descriptor of the list of things to be taught and learned. During and after this workshop, care was taken to discuss the broad range of meanings associated with curriculum before beginning to engage with the key focus—inclusivity. It was also clear that a half-day workshop was too long as most people could only stay for part of it. These two factors meant that the workshop was subsequently reduced to two hours and could not include as much reflection and planning for the participant’s own teaching as had been planned.

Swinburne University visit

As a result of the Melbourne workshop in July, an invitation was received for Julie Mills to attend Swinburne University for two days to work directly with the engineering academic staff and program leaders on gender inclusive strategies for their courses and programs. The visit incorporated a two-hour seminar presentation
and discussion open to all staff, a meeting with the leaders of each of the engineering programs and individual meetings with any staff on request.

**Conference and other presentations**

Conference presentations related to the project (in addition to the workshops discussed previously) were made by one or more of the project leaders as follows:


A further presentation on the project was made to a joint meeting of the Australian Council of Engineering Deans (ACED), Australian Council of Deans of Information and Computer Technology (ACDICT) and the Associate Deans Teaching and Learning in Engineering and IT on 6 December 2009 at the Engineering and Technology Education, leaders Forum.

**Webinar**

In November 2010 project leaders Julie Mills and Judith Gill from the University of South Australia in conjunction with Mary Ayre from the reference group were invited to present a webinar on the book gender inclusive engineering education through the IEEE (Institute of Electrical and Electronic Engineers). This is a worldwide organisation that involves a very large international community of electrical engineers and related disciplines. This webinar attracted more than 200 registrations globally with 45 participants logging on during the actual presentation. It was broadcast simultaneously to the USA, Europe, Australia and basically anywhere in the world where people were able to log in. The link to the recording of the webinar is provided in the Resources list in Chapter 7 and on the project website. It is available free on the web to all, not just to IEEE members. In this way the webinar was felt to be a highly effective medium for both interactive presentation at the time, and as a longer-term resource.
6.0 Accreditation

Introduction

Engineering and construction management programs in most countries are subject to accreditation by the relevant national or international professional bodies. Accreditation bodies have considerable power and influence over the curriculum and the leverage to change it. Historically, accreditation criteria were often cited as a reason to maintain the status quo and many proposed curriculum initiatives foundered on the accreditation rock. However, more recently, accreditation boards have begun to promote change in the undergraduate curriculum and pedagogy by becoming much less prescriptive about absolute requirements for content and structure in favour of specifying outcomes that programs are required to achieve. This has opened the way for significant curriculum change in some institutions.

Accreditation may set the framework, but the actual curriculum, quality systems to regulate and maintain it and the education environment in any university is controlled by the academic leaders and faculty members. Hence requirements to implement gender inclusive curriculum measures can be particularly influential if they are contained within accreditation guidelines, but institutional leadership is also critical in ensuring that the implementation occurs.

Engineers Australia

Accreditation for engineering programs in Australia is entirely the responsibility of Engineers Australia. The accreditation criteria used by Engineers Australia cover three areas: educational environment; academic curriculum and quality systems. The expectations for each of these assessment criteria are interpreted through a range of performance indicators which are intended to be used as guidelines rather than prescriptions. The ultimate focus is on the curriculum learning outcomes to ensure individual graduates satisfy, in a holistic sense, the 17 “elements of competency” in the Stage 1 Competency Standard.

In a consultative process that was part of ALTC project PP8-844 (curriculum specification and support systems for engineering education that address revised qualification standards), Engineers Australia has almost completed a revision of these into 16 elements, covering the knowledge and skills base (six elements), ability in engineering application (four elements) and personal and professional abilities. In the revised Competency Standard, each of these is elaborated in up to eleven items that express “evidence of attainment”. Engineers Australia hopes that engineering program and course designers use these statements to assist them to develop their curricula to meet the accreditation standards. Several of the evidence items are more likely to be realised in an inclusive curriculum, including, for the professional engineering qualification:

- Element 2.3: Application of systematic engineering synthesis and design processes – point (b) “addresses broad and contextual constraints … as an integral part of the design process”

- Element 3.2: Effective oral and written communication in professional and lay domains – point (a) “Proficiency in listening, speaking, reading and writing English, including comprehending critically and fairly the viewpoints of others, … appreciating the impact of body language, personal behaviour, …”

- Element 3.6: Effective team membership and team leadership – point (b) “Functions … in teams, including those with multi-level, multidisciplinary and multicultural dimensions”

The accreditation process expects to see evidence of these elements being
achieved through the curriculum and the supporting quality systems that is needed to sustain them. The latter would include systematic curriculum and assessment design processes that are internally reviewed and externally benchmarked; and systematic staff appointment, promotion and support processes. To assist faculties to meet its criteria, Engineers Australia provides comprehensive guidelines and advice on its expectations. It is within these that the outcomes of this project can add value. After adopting its revised Stage 1 Competency Standards, Engineers Australia intends to revise its guidelines. Suggestions from this project have been submitted to ensure that such revision makes due reference to the outcomes of this project. The project submission to Engineers Australia for this purpose is provided in Appendix B. The guidelines revision process will take place in 2011.

Adoption of the principles of inclusive curriculum in these accreditation guidelines, will flow to the faculties individually, and together, via promulgation and support from the Australian Council of Engineering Deans.

Accreditation of construction management programs

For construction management programs, there are numerous accrediting bodies and hence the situation is much more complex. Professional bodies that accredit some or all of the construction management programs in Australia include:

- Australian Institute of Building (AIB)
- Australian Institute of Quantity Surveyors (AIQS)
- Australian Institute of Building Surveyors (AIBS)
- Royal Institute of Chartered Surveyors (RICS)
- Chartered Institute of Building (CIOB)

Engagement with these bodies has been more problematic than with engineering due to the large number and the different accreditation processes and guidelines that each uses. Although we had representation from most of these bodies on either the project team or reference group, a clear methodology of how to achieve any influence on accreditation criteria was not developed during the project as a result of the complexity of the competing bodies. Instead it was resolved that we would provide the guidelines document and accreditation advice that had been sent to Engineers Australia to the accrediting arm of each of these bodies with a covering letter explaining the project and recommending that they consider a similar approach in their next review of accreditation guidelines. Informing the AIB, AIQS and AIBS about the recommendations of this project is timely. They are at present negotiating a Cooperative Accreditation Agreement For Education Providers between themselves which is due for implementation in 2011 (AIB, AIBS, & AIQS, 2006).
7.0 Resources

A range of resources has been produced during the project, all of which have been described in more detail in Chapter 5. The list below is a summary of where these resources can be accessed, as well as some additional resources that were not produced by the project but that will be of value to those academics who wish to access further useful information in the area of gender inclusive curriculum.

Project website
The project website address is http://resource.unisa.edu.au/course/view.php?id=568

Book
Mills, J. E., Ayre, M. E. and Gill, J. (2010), Gender Inclusive Engineering Education
New York: Routledge

The book may be obtained from the publisher and other online academic bookshops.

Guidelines

The Guidelines document may be obtained by downloading the PDF from the project website. Multiple hard copies were also distributed to Associate Deans Teaching and Learning at all universities offering engineering programs in Australia in late 2010, for dissemination to engineering academic teaching staff.

Webinar

Additional resources: exemplars of inclusive curriculum practice


8.0 Conclusions and recommendations

Summary of achievements against stated aims, deliverables and outcomes of the project

<table>
<thead>
<tr>
<th>Project Aims</th>
<th>Achievements/comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Raise awareness of the need for inclusive curricula in E&amp;CM among academic leaders, program designers, teaching staff and students in these disciplines.</td>
<td>Achieved through the workshops, presentations to engineering associate deans, benchmarking surveys with students and teaching staff at partner institutions, published articles in conferences and magazines.</td>
</tr>
<tr>
<td>2. Initiate and establish a national monitoring device which publishes regularly the gender-disaggregated statistics on enrolments and graduations in E&amp;CM (Such as currently occurs in the US through the American Society for Engineering Education, ASEE).</td>
<td>Engineers Australia completed a detailed study and publication of these data for engineering in November 2007 which is linked to the project website, along with additional data. The forthcoming ALTC report from Godfrey &amp; King (2010) also contains further relevant statistics. Hence it was felt that this aim was already met.</td>
</tr>
<tr>
<td>3. Develop and present a theoretical framework for the design and implementation of inclusive curriculum, relating learning theory to practical examples.</td>
<td>Featured in the book <em>gender inclusive engineering education</em>. A copy has been sent to the relevant associate dean teaching and learning for engineering or construction management at each university in Australia.</td>
</tr>
<tr>
<td>4. Collect and develop exemplars of inclusive curriculum content and implementation strategies at program and course level.</td>
<td>Compiled and presented in the book and on the project website.</td>
</tr>
<tr>
<td>5. Disseminate inclusive curriculum resources and strategies to staff in E&amp;CM faculties across Australia using forums, project website and established online networks.</td>
<td>Achieved by distribution of the book and Guidelines document through ACED and ACBED associate deans’ networks and project team members. Website address disseminated through workshops, publications and ALTC website.</td>
</tr>
<tr>
<td>6. Work with universities to embed inclusivity in graduate outcome statements and course and program approval processes.</td>
<td>Guidance on what needs to be done to achieve this is provided as Chapter 7 of the book, which has been distributed to all universities with E&amp;CM programs in Australia.</td>
</tr>
<tr>
<td>7. Combine with relevant industry bodies such as Engineers Australia (EA), Australian Council of Engineering Deans (ACED), Australasian Universities Building Education Association (AUBEA) to ensure that the principles of inclusive curriculum are valued and embedded within accreditation criteria for E&amp;CM programs in Australia.</td>
<td>Submission made to achieve this within the current review of Engineers Australia accreditation process. Outcome will not be known until 2011. Not able to achieve with construction management accrediting bodies due to conflicting requirements. Copies of the guidelines document were sent with explanatory information to each of the relevant bodies.</td>
</tr>
<tr>
<td>Project deliverables</td>
<td>Achievements/comments</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>News items/announcements of the project, website development and maintenance (aim 1). The website will be linked directly from the project description on the ALTC website.</td>
<td>Announcements/news items during project in Engineers Australia magazine, APESMA magazine, Campus Review, CIOB Contact magazine. Website has been linked to ALTC site.</td>
</tr>
<tr>
<td>A gender-disaggregated database, posted on the website, of students in E&amp;CM courses around the country in terms of program of enrolment, institution, access, participation and retention (aim 2)</td>
<td>Statistical information has been included on the website although not by institution. Links have also been provided to other useful sources such as the Engineers Australia report on this topic published in November 2007.</td>
</tr>
<tr>
<td>State-based workshops at UniSA and collaborating universities (aims 4,5 and 6) to showcase examples of inclusive curricula at various scales (activity, course, program)</td>
<td>Workshops were conducted in 2010, as detailed in Chapter 5.</td>
</tr>
<tr>
<td>Multi-mode resources – website, manual, CD (aims 5 and 6) - giving full details of inclusive curriculum exemplars across a range of teaching and learning areas</td>
<td>Website, book and guidelines document with this information have been completed and distributed to associate deans teaching and learning at each university.</td>
</tr>
<tr>
<td>Workshops with industry bodies (aim 7)</td>
<td>Separate workshops with industry bodies were not held but representatives of these bodies attended the university and conference workshops. Contact was also made with industry accrediting bodies as detailed in Chapter 6.</td>
</tr>
<tr>
<td>Scholarly publications – journal, conference presentations (aims 3,4,5,6)</td>
<td>Outputs included one book and two conference papers. A journal paper is in preparation.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Project Outcomes</th>
<th>Achievements/comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased awareness of inclusive curriculum in E&amp;CM staff and students</td>
<td>Achieved for some staff and students, mostly at partner institutions, through workshops and benchmarking surveys</td>
</tr>
<tr>
<td>Changes to practice of teaching and learning in E&amp;CM in line with inclusive curriculum</td>
<td>Workshop participant comments indicated this would occur for their teaching and learning. Widespread dissemination of the guidelines and other resources, combined with the accreditation approaches will assist to achieve this.</td>
</tr>
<tr>
<td>Closer cooperation between university staff on issues of inclusive curriculum</td>
<td>Workshop participants commented on new understandings and approaches and are engaged in continuing dialogue with members of the project group. Project partners themselves have expanded their collaboration and networks around these issues.</td>
</tr>
<tr>
<td>The embedding of inclusive curriculum principles into institutional quality processes for course and program development and approval</td>
<td>See Aim 6</td>
</tr>
</tbody>
</table>
The embedding of inclusive curriculum principles into accreditation criteria for E&CM programs with the relevant accrediting bodies

See Aim 7

Improved retention rates of women in E&CM in the longer term

The project will contribute to this but data to monitor cannot be gathered within the term of the project. Ongoing monitoring of retention is a key recommendation of the Godfrey & King 2010 report.

Project limitations

Innovation and change in university teaching crucially depends on the availability of quality materials to support teachers to devise new approaches in their teaching and learning. The guidelines for inclusive curriculum design along with the collection of exemplars published in the book, on the website and used in the workshops have the potential to change teaching and learning approaches. However, the current resource situation of Australian universities where academics face heavy teaching loads and/or significant pressures to prioritise research over teaching means that many are reluctant to attend professional development workshops in teaching. This meant that face to face interaction with academics during the project was constrained. However the variety of education and dissemination techniques adopted within the project should significantly extend its reach. In addition the embedding of inclusive principles within accreditation requirements of engineering will drive more systemic change. Opportunities for similar embedding are being explored in construction management.

During the project we encountered significant difference in the awareness of gender and curriculum between the two areas of engineering and construction management. The project expected that they could be joined together in this initiative, due to their similar profile. However this overlooked the significant history in engineering of educational reform and reflexivity, with some focus on gender, which has not characterised construction management education to date. This meant that the project had to focus much more on awareness-raising, basic knowledge of gender and the curriculum and communicating the rationale for the project than was anticipated. As a result some of the planned project phases, such as trialling and evaluating inclusive strategies at partner universities, were not attempted.

Recommendations

Recommendations arising from the project are provided below for the range of people and organizations who can influence the development and adoption of gender inclusive curriculum.

Accreditation bodies:
Provide the framework and impetus for achieving gender inclusivity in engineering and construction management curriculum and practice.

*Recommendation 1:*
Modify accreditation criteria and performance indicators to ensure that they incorporate issues relevant to gender inclusivity. For Engineers Australia this can be achieved by adoption of the recommendations provided to them by the project (refer Appendix 2).

*Recommendation 2:*
Adopt the *Guidelines for the design of inclusive engineering education programs*
document as an approved reference for Engineers Australia and construction management accrediting bodies.

**University leaders in engineering and construction management:**

Provide leadership and guidance that support staff to develop and adopt gender inclusive curriculum and practice:

**Recommendation 3:**
Benchmark E&CM programs and schools with respect to inclusivity in accordance with the *Guidelines for the design of inclusive engineering education programs* document to determine current practice.

**Recommendation 4:**
Develop action plans to achieve level 5 inclusivity benchmarks.

**Recommendation 5:**
Ensure academic staff have ongoing access to training to facilitate development and implementation of inclusive curriculum.

**Recommendation 6:**
Encourage commitment to innovation and excellence in teaching and learning by academic staff through programs for recognition and reward, including academic promotion.

**Academic staff in engineering and construction management:**

**Recommendation 7:**
Engage in professional development and participate in conversations about teaching, learning and curriculum that include gender inclusive practice. The resources produced by this project will assist you to do this.
9.0 References


Mills, J.E., Mehrten, V., Smith, E.J., and Adams, V. 2007 “Would you choose an engineering degree course if given the choice again?”, 18th Annual conference of Australasian Association for Engineering Education 10-12 December, Melbourne, Australia on CD Rom.


Appendix 1: Benchmarking survey

The survey below was administered at each of the partner institutions to both teaching staff and students in engineering and construction management. Staff surveys referred to courses or programs that they taught whereas student surveys referred to their overall experience during their engineering or construction management program. Each survey was modified to reflect the program and course names and terminology specific to that institution and was administered via email invitation to complete an online survey.

Example of staff survey:

SURVEY OF INCLUSIVE EDUCATION PRACTICES IN ENGINEERING AND CONSTRUCTION MANAGEMENT

STAFF SURVEY

An inclusive education is one in which the diversity of the student population in terms of gender, race, age, disability, cultural background and sexual orientation is respected and acknowledged within the content of a degree and demonstrated through teaching and learning methods.

Please answer all these questions based on the courses you usually teach in engineering or construction management at NAME OF INSTITUTION.

Please note that this questionnaire is intended for research purposes only and is not intended for teaching evaluation purposes, so please answer as openly and honestly as possible. The questionnaire will take a maximum of 10 minutes to complete.

<table>
<thead>
<tr>
<th>Heading: Base Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Are you</td>
</tr>
<tr>
<td>☐ Female</td>
</tr>
<tr>
<td>☐ Male</td>
</tr>
<tr>
<td>2. In which age group are you?</td>
</tr>
<tr>
<td>☐ 20-29</td>
</tr>
<tr>
<td>☐ 30-39</td>
</tr>
<tr>
<td>☐ 40-49</td>
</tr>
<tr>
<td>☐ 50-59</td>
</tr>
<tr>
<td>☐ 60 or over</td>
</tr>
<tr>
<td>3. Is English your first language?</td>
</tr>
<tr>
<td>☐ Yes</td>
</tr>
<tr>
<td>☐ No</td>
</tr>
<tr>
<td>4. In which discipline(s) are you currently teaching? (If more than one, please indicate your primary teaching area)</td>
</tr>
<tr>
<td>☐ Civil Engineering</td>
</tr>
</tbody>
</table>
Gender inclusive curriculum in engineering and construction management

Please click on a response from levels 1 – 5 which represents your assessment of the level reached WITHIN YOUR COURSE(S) on the aspect of inclusivity described for each question. Note that descriptions of Levels 1, 3 and 5 are provided but you can use 2 or 4 if you think that your experience is somewhere between levels 1, 3 and 5. It is recognised that your experiences are likely to vary considerably from course to course, so please try to represent your experience of the majority of course(s) you teach.

5. How is theory, or fundamental or contextual information taught within your course(s)?
   - Level 1. It is taught largely in isolation
   - Level 2.
   - Level 3. It is presented in terms of specific industry related problems
   - Level 4.
   - Level 5. Social effects are considered and debated wherever possible

6. What kinds of problems are used in your course(s)?
   - Level 1. Problems usually require focus on technical detail only
   - Level 2.
   - Level 3. Problems acknowledge societal needs but are still primarily technically focused
   - Level 4.
   - Level 5. Problems are open ended and focus on both societal and technical needs in their solution

7. Are problems approached in a multidisciplinary manner (e.g. do they draw upon or link to a range of other academic areas, such as architecture or other engineering disciplines)?
   - Level 1. Strictly single-discipline approach
   - Level 2.
   - Level 3. Includes awareness raising material and uses content from other disciplines, but this is not necessarily integrated with the rest of the content
   - Level 4.
   - Level 5. Approach is multidisciplinary

8. How are non-technical professional skills such as communication, team work, project management, organisational skills incorporated into your program(s)?
   - Level 1. Non-technical skills are developed in only one or two courses
   - Level 2.
   - Level 3. Some courses integrate technical and non-technical professional skills into content and assessment
   - Level 4.
   - Level 5. All courses integrate technical and non-technical professional skills into content and assessment wherever possible and in a coherent way

9. What is the basis of assessment in your course(s)?
   - Level 1. Assessment tasks concentrate on technical knowledge
   - Level 2.
Level 3. Assessment tasks assess technical and a small range of non-technical skills
Level 4. Assessment tasks, methods and criteria test a broad range of technical and non-technical skills

10. Do you assume that students already have some informal knowledge before commencing your course(s)? (e.g. is it assumed that they know how a car engine works or that they are familiar with computer spreadsheet software)?

Level 1. At commencement of the course, students are expected to have some degree of knowledge which is not formally taught in prerequisite courses, e.g. previous experience with electrical or mechanical components
Level 2.
Level 3. Curriculum content assumes no knowledge outside prerequisite curriculum
Level 4.
Level 5. All required content is included in the curriculum and is structured to build on informal experiences that will be familiar to a diverse range of students, e.g. household items and technology

11. Is prior knowledge of laboratories and equipment used assumed in your course(s)?

Level 1. Students are assumed to be competent in the use of equipment, machinery, apparatus, and computers
Level 2.
Level 3. Students receive a basic introduction to equipment, apparatus, etc. relevant to the course
Level 4.
Level 5. Further assistance is offered for all students who want to build skills or confidence, such as additional familiarisation sessions. Practical sessions are organised to ensure that all students are active participants and all tasks, including scribing, are shared. Use of equipment of any type is monitored to ensure all students are participating actively

12. How are women’s interests, experiences and achievements represented within your course(s)?

Level 1. Women’s interests, experiences and achievements are not represented
Level 2.
Level 3. Content acknowledges women’s interests and includes women’s experiences and achievements.
Level 4.
Level 5. Women’s interests, experiences and achievements are fully integrated into the curriculum

13. A learning environment includes all aspects of physical and social spaces experienced by students in their study. How would you describe the learning environment you create in your course(s)?

Level 1. I don’t do anything in particular to create a co-operative and supportive learning environment
Level 2.
Level 3. I work hard to create co-operative learning environments where the diverse range of students’ experiences are valued
Level 4.
Level 5. All staff develop co-operative learning environments where the diverse range of students experiences are valued
14. Discrimination may be defined as not receiving equal access to opportunity, based on characteristics such as gender, race, age, disability, marital status or pregnancy. For example sexual harassment may be defined as any unwanted sexual advances or unwelcome conduct of a sexual nature. How do you deal with discrimination and harassment if it occurs in your program(s)?

☐ Level 1. No attempt is made to prevent and eliminate discrimination and harassment in the teaching and learning environment
☐ Level 2.
☐ Level 3. Some attempt is made to address discrimination and harassment in the teaching and learning environment but it is not consistent across all courses
☐ Level 4.
☐ Level 5. The prevention of discrimination and harassment is consistent across all courses in the program. Inappropriate behaviour is dealt with. Policy is reinforced to students by staff

15. Have you experienced inappropriate language (e.g. racist or sexist), humour or images in your program(s)?

☐ Level 1. Inappropriate language, humour or images have been used in classrooms, assignments or other meetings by a number of staff and/or students
☐ Level 2.
☐ Level 3. Most staff do not allow inappropriate language, humour or images to be used in classrooms, assignments or other meetings
☐ Level 4.
☐ Level 5. Staff consistently take responsibility for stopping inappropriate interactions or comments in the classroom

16. Gender inclusive education treats men and women equally, is equally available to males and females and avoids any suggestion of either men or women being ‘naturally’ good at particular forms of learning. Is there any comment you would like to make regarding gender inclusive education in your program at UniSA? For example, you may like to provide an example of good practice or comment on the relevance of this topic to your teaching, or expand on one of your responses above

17. Do you have any other comment?

Thank you for your participation.
Appendix 2: Accreditation submission to Engineers Australia

Emeritus Professor Alan Bradley
Associate Director: Accreditation
Australian Engineering Accreditation Centre
Suite 206, 21 Bedford Street
Melbourne 3051

7 October 2010

Dear Professor Bradley

Suggestions to incorporate gender inclusivity into Engineers Australia accreditation criteria and processes

The 2007-8 ALTC-funded review of engineering education *Addressing the supply and quality of Engineering graduates for the new century* (King, 2008) recommended more female-friendly engineering education and workplaces to redress the continuing low rate of female enrolments in engineering. The report proposed specific action within its recommendations for implementing best-practice engineering education to “define and implement inclusive curriculum for engineering: reducing male stereotypes within the curriculum”\(^2\).

The development, dissemination and embedding of gender inclusive curriculum into engineering programs in Australia has been the focus of a current ALTC grant CG8-696 *Gender inclusive curriculum in engineering and construction management* led by Associate Professor Julie Mills at the University of South Australia, with a reference group chaired by Emeritus Professor Robin King.

Recognising the importance of accreditation as a driver for change, and as part of the current ALTC project’s strategy to embed inclusive curriculum principles into program development, the project team proposes that amendments should be made to the current *performance indicators* in the Engineers Australia document *S02 Accreditation Criteria Summary*. This strategy will help to ensure that all institutions consider these issues in their program and course development and implementation procedures, as well as in their administrative and quality structures.

In addition the team recommends that the document *Guidelines for the Design of Inclusive Engineering Education Programs* (attached separately) should be included as an approved external reference in the accreditation document *G09 Approved External References*.

---

Dr Julie E Mills
Project leader, ALTC CG8-696 *Gender Inclusive curriculum in Engineering and Construction Management*
Associate Professor and Program Director in Civil Engineering
School of Natural and Built Environments
University of South Australia
MAWSON LAKES, SA 5095, AUSTRALIA
Phone: 61 8 8302 3073
Email: julie.mills@unisa.edu.au

---

\(^2\) King, R. 2008, *Addressing the supply and quality of Engineering graduates for the new century*, p. 107
Gender inclusive curriculum in engineering and construction management

Engineers Australia Accreditation Criteria Performance Indicators – extracted from document S02

The list below highlights those elements of the current performance indicators that are already relevant to gender inclusivity (in green) and provides some suggested amendments and additions (in yellow). Many of these recommendations derive from an earlier document produced by the University of Newcastle who are partners in the current ALTC grant. 3

4.1. The Operating Environment

4.1.1 Organisational structure and commitment to engineering education

- Substantive, organisational entity with clearly designated and devolved accountability for leadership and management of engineering education programs.
- Long term, institutional commitment and strategic management to assure the development of the engineering discipline and the provision of appropriate resources.
- Formally constituted committee structures and mechanisms for program review and approval.

4.1.2 Academic and support staff profile

- Adequate academic staff numbers, balanced profile across academic appointment levels.
- Appropriate student/staff ratios.
- Effective workload policies and practices.
- Effective student learning support mechanisms.
- Gender balance.
  
  **Suggested amendment for this criteria**: A balanced mix of academic staff in terms of both gender and cultural background (with a goal of 30% female staff and 30% non-English speaking background)
- Appropriate depth, mix and distribution of qualifications, experience and engineering practice exposure, scholarship and professional standing.
- Match of staff competency profile to the range of specialist program offerings.
- Appropriate policy and record of staff development – both pedagogical, and professional skills.
- Staff awareness of gender and cross-cultural issues, inclusive teaching approach.
  
  **Suggested amendment for these criteria combined**: Substantial professional development opportunities for academic staff be regularly available for both pedagogical and professional skills. This should enable staff to develop appreciation of gender and cross-cultural issues and inclusive teaching practice. Participation in such staff development should be documented.
- Strategic use of sessional and industry presenters to enrich staff skills profile and the exposure of students.
- Adequate student counselling and advisory services.
- Appropriate technical and administrative support staff profiles.

4.1.3 Academic leadership and educational culture

- Effective leadership of a cohesive teaching team, driving the educational design and improvement process at individual program level.
- Program team inclusive of all teaching staff (including casual staff who desire involvement)
- Dynamic, cooperative learning community.

3 Jost, R. 2004, Benchmarks for Cultural Change in Engineering Education, University of Newcastle.
Progressive pedagogical framework, adoption of best practice.
- Cooperative industry and community outreach.
- Interlinked research and teaching programs.
- Staff role modelling the generic engineering attributes.
- Inclusive environment – gender, culture, social differences – encouraging diversity and the development of the individual.
- Developing staff as learning facilitators in a cooperative learning environment.

4.1.4 Facilities and physical resources
- Appropriate experimental and project based facilities to support both structured and investigatory learning within the specified field of practice and specialisation.
- Adequate IT facilities and support.
- Access to simulation, visualisation, analysis, design, documentation, planning, communication and management tools as well as test and measurement equipment and information resources appropriate to current industry practice.
- Learning support facilities appropriate to the development of the full range of educational outcomes and matching the needs of the individual.

4.1.5 Funding
- Sound business planning accommodating current commitments and proposed developments.
- Appropriate funding formula for distribution to and within the engineering school.
- Ongoing viability - ability to deliver current commitments and projected developments.

4.1.6 Strategic management of student profile
- Viable student numbers and trends.
- Appropriate admission, retention and progression record, Honours and graduation rates commensurate with performance indicators. The statistics gathered should be such that they can be disaggregated by gender and ethnicity.
- Rigorous processes for analysis, assessment and verification of prior learning for advanced standing.

4.2. Academic Programs

4.2.1 Specification of educational outcomes
- Clearly identified field of engineering practice and specialist focus.
- Explicit and comprehensive specification of program objectives and targeted graduate capabilities.
- Satisfactory rationale based on analysis of industry and community needs, trends in professional practice and benchmark indicators.
- Targeted graduate capabilities embracing the balanced development of enabling skills and knowledge; personal and professional capabilities; engineering application skills; competence in the technical domains comprising the field of practice and high level technical skills in nominated specialist areas.
- In-built performance indicators commensurate with an appropriate monitoring methodology.
- Targeted graduate capabilities reflecting the Stage 1 Competency Standard.
- Explicit mapping of educational outcomes to demonstrate adequate level of attainment of the Engineers Australia Generic Attributes.

4.2.2 Titles of program and award
- Titles appropriate to a program of professional engineering education.
- Match of title to designated field of practice, program content and specialist focus.
4.2.3 Program structure and implementation framework
- Structure compatible with the delivery of the specified outcomes.
- Dual degree pathways providing valid engineering outcomes.
- Alternative implementation pathways such as electives, major and minor sequences, cooperative mode, project/thesis options, workplace learning, distance mode and articulation routes providing equivalence of learning outcomes.
- Flexible structure adaptable to student backgrounds and individual learning abilities.
- Internationalised approach.
- Grading of learning experiences over program duration to develop independent learning skills.

New section: Teaching and learning environment
- Facilitation of cooperative learning environments through provision of appropriate facilities and staff development
- Consistent application of university anti-discrimination and harassment policies in all learning environments by all staff. Regular reinforcement of these policies to staff and students by senior management.
- Inclusive language is used by all staff at all times.
- Staff taking responsibility for challenging inappropriate language and activities in classrooms or by colleagues.
- Laboratory and practical sessions are organised and monitored to ensure that all students actively participate and use relevant equipment, with additional support sessions provided where necessary.

4.2.4 Curriculum content
Appropriate range, depth, and balance of learning to provide:

ENABLING SKILLS AND KNOWLEDGE DEVELOPMENT
- Developing underpinning capabilities in:
  - mathematics,
  - physical, life and information sciences,
  - engineering sciences, appropriate to the designated field of practice.
- Tackling technically challenging problems from first principles.

IN-DEPTH TECHNICAL COMPETENCE
- Appropriate range and depth of learning in the technical domains comprising the field of practice, consistent with employer expectations and international benchmarks.
- Application of enabling skills and knowledge to problem solution in these technical domains.
- Meaningful engagement with current technical and professional practices and issues in the designated field.
- Advanced knowledge and capability development in one or more specialist areas through engagement with:
  - the specific body of knowledge and emerging developments,
  - problems and situations of significant technical complexity.

PERSONAL AND PROFESSIONAL SKILLS DEVELOPMENT
- Embedded, cohesive approach addressed by the curriculum as a whole with particular emphasis on developing:
  - an ability to communicate with the engineering team and the community at large, information literacy and the ability to manage information and documentation, creativity and innovation,
  - an understanding of and commitment to ethical and professional responsibilities.
- an ability to function as an individual and as a team leader and member in multidisciplinary and multicultural teams;
- a capacity for lifelong learning and professional development;
- appropriate professional attitudes.

ENGINEERING APPLICATION EXPERIENCE
- Pervasive engineering application activities in technical domains appropriate to the designated field of practice and directed at developing:
  - advanced level skills in the structured solution of complex and often ill defined problems;
  - ability to use a systems approach to complex problems, and to design and operational performance;
  - proficiency in the engineering design of components, systems and/or processes in accordance with specified and agreed performance criteria;
  - skills in implementing and managing engineering projects within the bounds of time, budget, performance and quality assurance requirements;
  - an ability to operate within a broad contextual framework assuming social, cultural, ethical, legal, political, economic and environmental responsibilities and upholding the principles of sustainable development and safety imperatives;
- skills in operating within a business environment, organisational and enterprise management and in the fundamental principles of business.

PRACTICAL AND ‘HANDS-ON’ EXPERIENCE
- Embedded experiential learning activities, appropriate to the technical domains within the designated field of practice, and directed at developing:
  - an appreciation of the scientific method, the need for rigour and a sound theoretical basis;
  - a commitment to safe and sustainable practices;
  - skills in the selection and characterisation of engineering systems, devices, components and materials;
  - skills in the selection and application of appropriate engineering resources tools and techniques, appreciation of accuracy and limitations;
  - skills in the development and application of mathematical, physical and conceptual models, understanding of applicability and shortcomings;
  - skills in the design and conduct of experiments and measurements;
  - proficiency in appropriate laboratory procedures; the use of test rigs, instrumentation and test equipment;
  - skills in recognising unsuccessful outcomes, sources of error, diagnosis, fault finding and re-engineering;
  - skills in documenting results, analysing credibility of outcomes, critical reflection, developing robust conclusions, reporting outcomes.

New Section: INCLUSIVITY
- All aspects of curriculum content should be developed to incorporate gender and culturally inclusive approaches such as:
  - Locating technical theory within applied, social and environmental contexts where possible
  - Selecting open-ended problems considering non-technical solutions or components where possible, rather than a focus on a single technical solution
  - Using multi-disciplinary approaches
  - Ensuring that all required background knowledge is incorporated within course or prerequisite course content rather than assuming informal prior knowledge
  - Providing a range of assessment opportunities and contexts to test a broad range of skills
4.2.5 Exposure to professional practice
- Exposure to engineering practice (other than formal work placement), used as an integrated learning activity embedded within academic units and contributing in a defined and understood manner to the delivery of graduate capabilities.
- Formal work placement requirements documented with appropriate learning outcome targets.
- Appropriate systems for recording, tracking and assessing delivery of learning outcomes.

4.3. Quality Systems

4.3.1 Engagement with external constituencies
- Ongoing, regular input to the establishment and review of outcome targets, educational design and performance assessment from a formal advisory body which includes representation of industry, the community and professional organisations.
- External stakeholders facilitating appropriate professional practice exposure opportunities for students.
- Productive industry linkages through collaborative project work and research contributing to the professional development of staff and students.

4.3.2 Feedback and stakeholder input to continuous improvement processes
- Consulting via staff-student consultation forums, focus groups or other means of direct input mechanisms for on-going review and improvement.
- Appropriate use of survey instruments and other means of obtaining systematic feedback.
- Seeking input from graduates, alumni, employers, advisory bodies and the community input mechanisms.
- Recognising and engaging students as true partners in a culture of continuous quality improvement.

4.3.3 Processes for setting and reviewing the educational outcomes specification
- Holistic, outcomes driven approach.
- Addressing the full range of graduate capabilities.
- Controlled by the generic attributes framework and aligned with the Stage 1 Competency Standard.
- Specific to each individual program.
- Systematic review process inclusive of all teaching staff and the ongoing input from external constituencies.
- Ongoing review of benchmark practices, industry needs and demand.

4.3.4 Approach to educational design and review
- Continuous improvement process involving all teaching staff.
- Driven by a clear understanding of the ‘big-picture’ – program objectives and graduate capabilities.
- Documented records of improvement processes.
- Closing the loop within academic units – learning outcomes - learning activities – assessment.
- Systematic mapping of learning outcomes from academic units, aggregating to deliver targeted graduate capability outcomes.
- Progressive emphasis on independent learning, reflective practices, critical review, peer and self assessment as the program progresses.

4.3.5 Approach to assessment and performance evaluation
- Integral to the educational design processes.
Adequate range and depth of assessment processes, referenced to relevant standards or benchmarks, including appropriate use of reflective, student self analysis against targeted learning outcomes and/or graduate capabilities.

Tracking and monitoring the attainment of the full range of graduate capabilities including personal and professional skills and standards of technical competence.

Tracking the performance measures within academic units and how these aggregate to satisfy the capability metrics for the program as a whole.

Rigorous moderation processes.

Systematic review.

Appropriate mechanism for determination of Honours level performance.

**4.3.6 Management of alternative implementation pathways and delivery modes**

Adequate processes for analysing, monitoring and ensuring the equivalence of alternative implementation pathways and delivery modes.

**4.3.7 Dissemination of educational philosophy**

Adequate documentation of the targeted program outcomes and the educational design philosophy and the associated mapping processes in program handbooks and records, and/or in individual academic unit guidelines.

Clear mapping of the component contributions from individual academic units to the graduate capability specification.

Clear linkage between learning outcome targets, learning activities and performance assessment within the individual academic unit.

Appropriately informing all stakeholders.

**4.3.8 Benchmarking**

Appropriate processes for comparing standards of educational outcome targets and performance criteria against the expectations of employers as well as national/international practice.

**4.3.9 Approval processes for program development and amendment**

Formal processes for:
- new program approval – demand analysis, establishing rationale, outcomes specification, educational design,
- program amendment.

**4.3.10 Student administration**

Robust systems for:
- student records data management,
- individual student progress monitoring, performance warning and exclusion,
- student advisory processes,
- retention and progression monitoring,
- defining and maintaining student admission standards
Appendix 3:

Gender Inclusive Curriculum in Engineering and Construction
Management – Final Evaluation Report
November 25, 2010

Dr Lesley Jolly
Strategic Partnerships
Gender Inclusive Curriculum in Engineering and Construction Management – Final Evaluation Report

November 25, 2010

This is the final evaluation report for the research project Gender Inclusive Curriculum in Engineering and Construction Management. The ultimate goal of the project is to encourage the enrolment and retention of a larger number of women in Engineering and Construction Management programs by disseminating guidelines and examples of gender inclusive curriculum.

The project commenced in October 2008 and ran through late 2010. The project aims to develop guidelines for gender inclusive curriculum in terms of content and teaching and learning practices, to disseminate examples of such curriculum and conduct workshops with Engineering and Construction Management academics around Australia to promote and develop inclusive practices. It also aims to work with accreditation bodies such as Engineers Australia to embed these principles into accreditation criteria for engineering and construction management degrees.

In accordance with the requirements of the funding body ALTC, the project needs to undergo evaluation. ALTC describes the evaluator role as: “a sounding board for the team, asking questions that will enable greater clarity and precision to be attached to planned processes and outcomes”. In this case the evaluator has been involved in the following project activities:

- a two-day meeting of the full project team in Adelaide in September 2009
- team planning meetings on 10 and 11 December 2009
- inclusive curriculum workshops at UniSA (18 February 2010) and UTS (16 April 2010)

Other workshops were held which the evaluator did not attend but a total of 7 interviews have been undertaken with participants from all workshops. A website and a book, Gender Inclusive Engineering Education, were also produced by the project team to further their aims and these are considered as part of this evaluation.
**Evaluation Plan**

A program logic approach was taken to this evaluation. That is, the evaluation seeks to describe how the research program is intended to cause the desired outcomes and to assess the likelihood of that logic’s succeeding. It is outside the scope of this evaluation or even the project as a whole to scrutinize such measures as the rate of female enrolments in the target professions and such impacts are explicitly not what the evaluation seeks to describe.

**The program logic approach**

The following table represents the goals of the project as a hierarchy of objectives. This table was articulated early in the project and forms the basis for discussion of the project’s success in addressing its objectives. It should be noted that it is distinct from the stated aims of the project team, though each are referred to in the following discussion. This table forms a means to independently evaluate the effect of the project.

<table>
<thead>
<tr>
<th>Hierarchy of Objectives</th>
<th>Underlying Assumptions</th>
<th>Summary Evaluation Results</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ultimate Objectives</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To increase enrolments and retention of women in engineering and construction degrees.</td>
<td>The shortage of engineers and construction managers can be remedied by attracting more women to these professions.</td>
<td>It is outside the scope of this project to evaluate results for this objective</td>
</tr>
</tbody>
</table>

As a matter of social justice increased female enrolment would improve distribution of the benefits accruing to prosperous societies, and ensure that a wider range of the citizens of these societies play an active and informed part in the control and use of their assets.

More women in these professions will ensure that the output will be more
<table>
<thead>
<tr>
<th>Accommodate the increasingly diverse student body.</th>
<th>A more diverse professional population will make decisions more representative of the diversity of society.</th>
<th>Diversity was a major focus of the project and there is evidence of substantial awareness raising as a result.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Embed inclusive principles into the structure of course approval processes, graduate outcome statements and the requirements of professional accreditation bodies.</td>
<td>Official recognition of diversity principles will maintain attention to this issue.</td>
<td>Processes have been put in train in the engineering discipline to embed recognition of diversity. For reasons discussed below, this has not been so successful in the construction management discipline.</td>
</tr>
<tr>
<td>Promote a more inclusive style of teaching and learning in engineering and construction.</td>
<td>Students feel alienated by curricula in which they don’t recognize their interests and ways of being and this results in their not enrolling or dropping out or not achieving/engaging to the level at which they could.</td>
<td>Clear evidence of recognized need and raised awareness as a result of the project.</td>
</tr>
</tbody>
</table>

**Intermediate Objectives**

<table>
<thead>
<tr>
<th>Raise awareness of the need for inclusive curricula in E&amp;CM among academic leaders, program designers, teaching staff and students in these disciplines</th>
<th>The lack of gender inclusiveness and the impact of that lack is not well recognized currently and this hinders changes that might attract and retain more women.</th>
<th>Clear evidence of recognized need and raised awareness as a result of the project.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initiate and establish a</td>
<td>Awareness of the gender imbalance</td>
<td>Proved not to be possible.</td>
</tr>
<tr>
<td>Task Description</td>
<td>Result</td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Develop and present a theoretical framework for the design and implementation of inclusive curriculum, relating learning theory to practical examples</td>
<td>A theoretical framework for inclusive curriculum would allow people to address a variety of specific situations in different institutions.</td>
<td></td>
</tr>
<tr>
<td>Collect and develop exemplars of inclusive curriculum content and implementation strategies at program and course level</td>
<td>Concise examples can be produced and their availability will encourage uptake.</td>
<td></td>
</tr>
<tr>
<td>Disseminate inclusive curriculum resources and strategies to staff in E&amp;CM Faculties across Australia using forums, project website and established on-line networks.</td>
<td>Telling people about the resources will lead to a change in teaching habits.</td>
<td></td>
</tr>
<tr>
<td>Work with universities and relevant industry</td>
<td>The project team will need to do some of the work for official</td>
<td></td>
</tr>
<tr>
<td></td>
<td>In train for engineering. Structural problems to be overcome in construction</td>
<td></td>
</tr>
<tr>
<td>Immediate Objectives</td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>---------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Provide information to universities, professional bodies and accrediting authorities.</td>
<td>The availability of information will lead to interest and hence to action.</td>
<td>Information provided through direct communication (eg AE), provision of copies of Mills et. al. (2010) and website.</td>
</tr>
<tr>
<td>Collate exemplars of gender inclusive curricula.</td>
<td>Teachers need examples in order to understand the principles.</td>
<td>Provided on website and in book.</td>
</tr>
<tr>
<td>Encourage and enable staff to adopt gender inclusive curricula through workshops.</td>
<td>Staff attending workshops will adopt principles and act as catalysts for change in their institutions.</td>
<td>Staff noted that the existence of workshops was a tacit support for inclusive strategies.</td>
</tr>
<tr>
<td>Promote dissemination of gender inclusive principles through networks, a blog and conference presentations.</td>
<td>GIC principles need to be further developed and spread through ongoing discussion and interaction.</td>
<td>Done.</td>
</tr>
<tr>
<td>Persuade professional accreditation bodies</td>
<td>Having GIC principles in accreditation criteria is a fundamental motive for</td>
<td>In train.</td>
</tr>
</tbody>
</table>
In order to evaluate the project in terms of its objectives, a variety of data was generated including observation of workshops, discussions with stakeholders, exit surveys from workshops and interviews with attendees from four of the workshops. This data was examined to determine what it demonstrated about the achievement of the project team’s stated aims, and the above table. The data was not designed to test the assumptions listed above, rather, only the statements that are expressed as objectives.

**Exit Surveys**

Following participation in the workshops, participants were asked to complete an evaluation in the form of a survey. Out of 28 participants, 18 responses were collected.

First, participants were asked to what extent the workshop:

(a) helped to clarify their understandings of the impact of curriculum on learning

(b) helped to clarify how gender figures in curriculum

(c) provided useful examples of inclusive approaches to curriculum

(d) motivated them to introduce inclusive principles to curriculum

(e) gave them strategies for introducing inclusivity in curriculum
The following table represents their answers, with the Y axis depicting how many responses in each of the ratings categories were received.

![Ratings of workshops by participants](image)

As can be seen from this, the majority of responding participants rated the workshop as considerably or moderately effective for each of the five questions. The average score for each question is as follows:

<table>
<thead>
<tr>
<th>Question</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question A</td>
<td>1.6</td>
</tr>
<tr>
<td>Question B</td>
<td>1.6</td>
</tr>
<tr>
<td>Question C</td>
<td>1.6</td>
</tr>
<tr>
<td>Question D</td>
<td>1.5</td>
</tr>
<tr>
<td>Question E</td>
<td>1.6</td>
</tr>
</tbody>
</table>

Where 1 is equal to the rating “considerable” and 4 is equal to the rating “not at all.” These results suggest that the workshops were successful in these five measures.

Participants were also asked to provide answers to the following open ended questions:

1. In my case the barriers to a more inclusive curriculum are:

2. Mechanisms I might use to overcome those barriers are:
They were also given the opportunity to provide any other comment about the workshops. As these responses are qualitative in nature, the results were analysed alongside data from extended interviews with a number of workshop attendees who volunteered to be interviewed.

Qualitative Data

The qualitative data that was collected from participants in the form of exit surveys and extended interviews was analysed in the program NVivo. The data was coded according to its relevance to the seven stated aims of the project. For each aim, a node was created as either positive evidence or negative evidence in support of that aim being achieved through the workshops. The list of aims is as follows:

1. **Raise awareness** of the need for inclusive curricula in E&CM among academic leaders, program designers, teaching staff and students in these disciplines.

2. Initiate and establish a national monitoring device which publishes regularly the gender-disaggregated statistics on enrolments and graduations in E&CM.

3. Develop and present a **theoretical framework** for the design and implementation of inclusive curriculum, relating learning theory to practical examples.

4. **Collect and develop exemplars** of inclusive curriculum content and implementation strategies at program and course level.

5. **Disseminate inclusive curriculum resources and strategies** to staff in E&CM faculties across Australia, using forums, the project website and established online networks.

6. Work with universities to **embed inclusivity** in graduate outcome statements and course and program approval processes.

7. Combine with relevant industry bodies…to ensure that the principles of inclusive curriculum are valued and embedded within accreditation criteria for E&CM programs in Australia.

As Aims 2 and 7 were not designed to be achieved through the workshop sessions, these were not addressed by participants, and will be discussed separately. Although many of the remaining aims were addressed in multiple ways during the project, all are ultimately dependent on the response of academic staff in universities. Accordingly, the views and responses of workshop
participants can be considered a good indicator of their achievement. The project stated a number of key outcomes:

- Increased awareness of inclusive curriculum in E&CM staff and students
- Changes to practice of teaching and learning in E&CM in line with inclusive curriculum
- Closer cooperation between university staff on issues of inclusive curriculum
- The embedding of inclusive curriculum principles into institutional quality processes for course and program development and approval

As such, the impressions, comments and feedback of workshop participants should be seen as key in the achievement of these aims. In particular, Aims 5 & 6 depend upon the support and efforts of participating academic staff, and their ability to identify and effectively use resources and strategies to improve gender inclusivity and embed it in the curriculum. It should be noted, however, that many of these aims were being pursued in a number of ways during the project, and that this data should not be considered as the sole indicator of their achievement.
Aim 1 – Raising Awareness

References for Aim 1 included any response which indicated whether the participant clearly understood the nature and extent of the problem of inclusivity in curricula. For example, one participant said that being gender inclusive meant changing the terminology used, and showing how engineering principles can be applied to a wide range of areas, using different examples from everyday experiences. This indicates a well developed understanding of the focus of the project. Conversely, another participant identified that due to vehicle parts and processes being a necessary part of the engineering curriculum, it’s difficult to think of replacements for these areas that teach the same set of skills and are more gender inclusive. This participant did not demonstrate an awareness that the way in which content and processes are approached in teaching and learning contexts has a significant impact on how students negotiate learning. These contradictory results reveal something of the nature of that awareness itself. All seven extended interview participants gave responses indicating that in a general sense awareness of the issue was present. However, five of these seven also gave responses that the nature of their understanding required further development, before they could be considered fully aware of the issues surrounding gender inclusivity.

Aim 3 – Theoretical Framework

References for Aim 3 indicate whether the participant had an understanding of the theoretical framework underpinning gender inclusivity in curriculum. Only one participant was able to link learning theory and gender inclusivity; demonstrated, for example, in the statement “quality teaching is inclusive.” The remaining participants who made comments referring to the theoretical framework indicated that this was an area for potential development. For instance, one participant identified that it was difficult to talk about the issues of gender and gender inclusion in curriculum because there was a “lack of [theoretical] clarity” underpinning the workshops. This was evidenced by a lack of understanding about the connection between learning theory and gender inclusivity, and about the connection between general and gender inclusivity.

Aim 4 – Collect and Develop Exemplars

Responses relating to Aim 4 are concerned with participants’ indication of the value, relevance and applicability they see in the provided examples and exemplars used in the workshop. For example, one participant stated that exemplars were good illustrations and acted as a catalyst for good discussion during the workshops. Especially, a number of participants commented that, being male, they needed examples to help them conceive of problems and solutions relating to...
gender in the curriculum, and that the workshop helped them to do this. Two participants indicated that examples and exemplars were less valuable, for example, stating that they had “fallen pretty flat” or that the value of the workshops was not in the ideas for curriculum changes that were presented, but in the opportunity to network with other academics.

Aim 5 – Disseminate IC Resources and Strategies

Results for Aim 5 indicate the response of participants to the workshop in terms of how it provided resources and strategies they could use to tackle the problem of gender inclusivity. In particular, many respondents referred to the (then) forthcoming website as a valuable resource which, in combination with the understandings developed through the workshops, could be used as a place to access further resources for developing strategies for inclusive curriculum. Participants also described a number of specific strategies that they were now aware of and able to build into their teaching practice, such as providing conscious contexts for learning, identifying marginalized students and building active support systems into course design. Conversely, four of the extended interview participants reported that participation in the workshop was useful for building their awareness of the issues, but that they didn’t know yet how to build inclusive strategies into their own teaching and curriculum design.

Aim 6 – Embedding Inclusivity

Responses for Aim 6 indicated participants’ views and positions about the process of embedding inclusivity in curricula, including the challenges they face in doing so, such as the degree of support of their colleagues, and the existing practices of their institution. Four participants indicated how they would attempt to embed more inclusive practices in their teaching and curriculum, for example, by re-examining specific assessment scenarios, through content delivery options, or through the design of the first and second year programs at their university. On the other hand, two participants stated that they had no concrete plans for change, and nine reported that they did not expect to receive support from other teaching staff, or that existing institutional practices would prevent them from developing a more inclusive curriculum.
Discussion

Overall, it suggested by this data that the aim of raising awareness for the need for more inclusive curricula in E&CM has been successfully addressed, at least as far as engineering is concerned. Whilst some participants demonstrated that their full awareness of how the issue relates to their own teaching practice was still in need of development, the majority of responses from participants strongly indicated that the project had had a positive impact on awareness, both for themselves, and in the message it sends back to the rest of their faculty at their university. It was stated by one participant that the fact that there was a workshop to attend on this issue lends credibility to the issue itself, and that this would help to gain a degree of support from other academic staff.

It provides you with a little bit of credibility... Why you're spending time on that when you could be collecting data for this other paper – if you know and can argue and articulate really clearly why you've been doing, why you've been spending time on this activity, then it feels a bit like you've got a bit of ammunition.

The achievement of the aim of raising awareness is also indicated by the results from the exit surveys, in which participants generally rated the workshop as either considerably or moderately effective in achieving outcomes related to awareness and understanding.

Less conclusive is the impact of the workshop and the project in general on the process of embedding inclusive practices in curriculum design and implementation. Whilst support of this aim was generally expressed by the participants themselves, many indicated that a lack of support from other academic staff and existing institutional practices remain a significant hurdle to overcome. For example, some stated that quality teaching was not a high priority in their faculty, and that even if the issue was recognized it was seen as “someone else’s problem.” It may be found, however, that the process of achieving this aim must be assessed in the longer term, as increased awareness has time to take its expected effect of increasing support. Such a timeframe is beyond the scope of this project, but we note that after one workshop, attendees from another university (Swinburne) invited the team leader to their institution to address academics as a way of beginning to raise awareness there, and thus promote the conversation.

Aim 4 & 5 may be seen as interrelated, as the project primarily aimed to achieve the dissemination of resources and strategies through the exemplars of inclusive curriculum used in the workshops, book and website. Whilst there was some negative evidence towards each of these aims, in both instances this was outweighed by the positive evidence for their achievement. One participant stated:
[the exemplars were] probably the most valuable thing, to see what people are doing. They weren’t exemplars that I can take back, but it’s the type of thing that others are doing…and it sort of gives them some ideas to start thinking, but it’s probably more what I’d be looking for and what I’d be keeping my eye out for.

As such, it may be said that the project has at least begun the process of disseminating resources and strategies which, in the future, will also support the achievement of more inclusive curriculum in E&CM, as academic staff put them to use.

A more successful understanding of the theoretical framework for gender inclusive curriculum offers an area for potential improvement which may also support this longer term goal. Only one of the participants expressed the theoretical understanding that learning theory and quality teaching are directly related to inclusive outcomes. To other participants at the time of being interviewed, this theoretical foundation was not clear.

I think a got a sense that I need to know about that rather than discovering it and that’s why I’m keen to get hold of the book … I certainly realised that I sort of need a better framework or someway of understanding it.

Exploring this more explicitly would likely have a positive impact on increasing detailed awareness about gender inclusivity, and support for and commitment to developing quality teaching practices. Having said this, participants’ views and understandings regarding the theoretical framework of the project may prove more positive once they have access to the book, which includes a detailed chapter on the learning theory which is seen to underpin the issue. Further, if the theoretical position which emphasizes the link between quality teaching and inclusion can be more generally understood and accepted, this may help to alleviate some of the problems expressed by participants regarding the hurdles to be overcome in their own faculties. Five of the respondents were also looking forward to having access to the website to give them strategies and help them communicate with colleagues. The website has only recently been made available so it is not yet possible to say how it will be used but the team plans to spread awareness of the site through:

- linking it from the project site on the ALTC website
- link it from the team leader’s homepage
- including it in the Resources section of the Final project report
• including it in the Guidelines document that is being sent out to all of the Assoc Deans T&L in Eng for distribution
• and also in Guidelines document to Engineers Australia aiming to be adopted as an Approved Reference document for accreditation

The Accreditation Committee of Engineers Australia will meet on December 1 to consider the proposal to include inclusivity into the accreditation guidelines and that is a direct outcome of this project.

Whilst there is no data available from participants about the effectiveness of the book and the website (only recently available), it is clear that these two resources actively support the achievement of the aims discussed above. The website is of particular use for those that are newly exploring the issue, highlighting the basic issues which the workshops dealt with in detail. This has particular value as an immediate resource for bringing more academic staff to a knowledgeable position on the issue as awareness increases. The book also supports this by providing a further, more detailed resource, and is of particular value for participants who wish to pursue the workshop focus in greater detail, with a view to translating the exemplars to their own curriculum development and implementation. It is hoped, particularly, that the book will support a better understanding of the theoretical foundation of the project and inclusive curriculum itself, thereby improving the outcomes of the project.

The one area where the project had problems was in engaging academics and institutional bodies in the construction management discipline, despite good support from team members in those disciplines. There are a number of reasons for this, including the much more hostile climate for women in construction management and a less developed academic community centred on teaching and learning and equity in the discipline. Starting from the top in seeking to embed principles in accreditation guidelines was also complicated:

*we haven’t been able to get any leeway with our accreditation bodies, partly because we’ve got six of them*

*I’m not quite sure how successful that’s been, but I’m pretty sure that it’s only because the professional bodies are really in a state of flux at the moment, because it’s a bad time*

Even awareness raising was thus starting from a much lower base in construction management and it is likely that further work will need to be done in that discipline before project such as this one can bear fruit.
In conclusion, the immediate and intermediate objectives stated above under “program logic,” and in the interim evaluation can be said to have been achieved during the project. The exception, the presentation of a clear theoretical framework, may prove to have been more successful following reassessment of participants’ understandings once they have read the book *Gender Inclusive Engineering Education*. Regardless, this offers an area for potential development in future work in the area.