Women in engineering - an innovative model enhancing diversity

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Abstract: *This paper presents an overview of an educational innovation at RMIT University - the Engineering Awareness Program for Girls (EAP).*

In the opening sections this paper discusses the pedagogical approach adopted in the EAP and considers how the EAP is effective in addressing low levels of access and participation in Engineering Programs. Specifically, consideration is given to how some of barriers, which prevent females from entering the engineering profession, are challenged and overcome.

We present the EAP as a successful strategy to attract more young women to study engineering and as an innovative community partnership model, which enhances graduate capabilities. This paper examines the factors, which influenced the original design and development of the EAP, considering both implementation and the factors, which determine sustainability through a cross-sectoral partnership approach.

Recommendations for the future are discussed in the context of examples from similar, successful programs offered overseas and in the context of RMIT's Teaching and Learning Strategy. More broadly, the EAP is discussed in light of RMIT's Mission to promote lifelong learning, innovation and community partnership building.

Keywords: *Graduate capabilities, Access and Equity in Engineering- supporting women in engineering, community engagement- RMIT University and local learning communities.*

Introduction

Since it's inception in 1997, the Engineering Awareness Program for Year 10 girls (EAP) has provided an innovative response to the under representation of women in the engineering profession. In 1983 approximately 5% of engineering graduates were women, a figure that only increased to 15% by 2000, (Lee, 2002). In Australia only 6% of practicing professional engineers are women, (Lee, 2002) In the case of RMIT, only 5% of engineering undergraduates were women in 1986. Over the past 15 years this has increased to 17% in 2001. In the VET sector, however, only 4% of engineering students at RMIT are currently women (RMIT Engineering Equity Unit, 2002).

The EAP provides an effective and innovative response to this gender imbalance and to date 240 students have participated in the program. The EAP targets girls in the middle school years, just prior to them making subject selections for the Victorian Certificate of Education, which will determine tertiary study choice. The EAP runs over two days between two and four times per year. The aim is for the program to take place before students make their final choices for VCE subjects, usually prior to October. Most of the sessions and workshops take place at the RMIT city campus, with one workshop at the Fisherman's Bend campus where Aerospace Engineering is offered.

The EAP for Year 10 Girls has for the past five years been a cooperative effort between the Equity Unit, Faculty of Engineering and CIECAP. CIECAP supports schools across Melbourne, and a key part of its focus is to enhance teaching and learning in science and technology and technology education. It is a division of RMIT's Community and Regional Partnerships in the School of Enterprise and Community Partnerships. The University's support for CIECAP and the projects it undertakes, such as EAP, is part of its broader commitment to Community and Regional Partnerships.

Program Design

The EAP provides Year 10 girls with the opportunity to participate in an interactive forum over two consecutive days and consists of the following:

Role Models: Presentations and informal discussions with female engineering students and female undergraduates currently working in the engineering industry. Speakers provide a snapshot of their lives, including influences they have had and obstacles they have overcome.

Informal discussions: Aimed at challenging some of the stereotypes, which underpin student's perceptions of the engineering profession

Information sessions; Student Recruitment provides an introduction to RMIT while the Careers Centre provides information and advice regarding various programs offered.

Hands on workshops: Activates offered in the workshops are developed by teaching staff from various departments. These are hands on and result in the student making something that they can take home, such as a CD holder or an aeroplane

Benefits

Female Secondary Students

Secondary students are given the opportunity to work with technologies not available to them in their schools and to experience a unique learning environment as they work with girls from a range of schools with whom they share common interests. The EAP encourages school students to develop problem-solving strategies, encouraging prediction, inquiry and reflective practice. Activities are designed to enable school students to understand the connections between each specific workshop and the skills and thought processes employed by engineers working in the profession, and to gain an insight into the diverse nature of the profession.

The EAP responds to the well-researched need to provide students with the opportunity to engage with the world outside institution or school, noted as a major issue at the first Global Conference on Lifelong Learning in 1996. By meeting with RMIT Alumni and

undergraduates, the engineering profession is demystified as young female engineers relate personal stories about their own study and career paths, reflecting on obstacles they have encountered and how these difficulties have been overcome. Further, school students are able to make connections between their own schooling and the worlds of further education and work. In reflecting on the EAP program, school students are encouraged to see how their feedback informs future program development. They are encouraged to share a commitment to inform their own communities about the diverse nature of the profession, and to challenge the stereotypes, which impose barriers to women entering the field of engineering.

Graduate Capabilities

Through participating in the Engineering Awareness Program, both young women in industry and RMIT undergraduates and postgraduates are encouraged to see themselves as significant and positive role models for female secondary students. The EAP encourages RMIT students and Alumni to see their role as engineers as one that supports diversity in the engineering profession by encouraging potential female engineers. This program enables undergraduates and Alumni to contextualise their own learning and work, and to understand and value lifelong learning and access for all. Further, the EAP fosters leadership skills, enhancing presentation and communication skills, supporting work readiness and career long learning. In reflecting on their own career and study choices, women develop a deeper understanding of their potential and capacity to make an invaluable contribution to the engineering profession and to society in general. The EAP provides RMIT female undergraduates with the opportunity to develop their leadership through contributing to the community in ways which `develop RMIT students to be knowledgeable, creative, critical, responsible and employable, as well as being life-long learners and potential leaders′ (RMIT Strategic Plan, 2000 to 2004.)

RMIT Teaching Staff

Through practical involvement in the EAP, RMIT lecturers and tutors become more aware of equity issues and of their relevance to current and prospective students. Staff are given the opportunity to reflect on their own academic development.

Continual Improvement

The EAP Programs form part of a continuing cycle of teacher and student evaluation, reflective practice and continued improvement in program design and delivery, ensuring that learning is relevant and responsive to students needs, providing the opportunity for students to pursue learning congruent with their interests. Programs are continually reshaped and developed as knowledge is integrated across disciplines and learning communities, and applied to the changing and emerging educational needs of students, both internal and external.

Women in Engineering

While women had long been under represented in higher education, this has remained particularly so in the field of engineering compared with other disciplines. As previously noted, very few women had studied engineering at Australian universities until quite recently.

The Williams ‘Review of the Discipline of Engineering’ was undertaken in 1988 and recommended that steps be taken to increase the number of female graduates (Bellis and Armstrong 1998, p. 27). Since then, many universities have addressed the issue by offering programs aimed at attracting girls into undergraduate engineering studies.

Strategies to encourage young women to study engineering

In Victorian universities, a number of strategies are being used to attempt to address gender imbalances in the engineering profession and encourage young women to consider engineering as a viable career option. Most engineering Faculties visit secondary schools to offer information sessions for both students and parents. Speakers at these sessions range from Faculty staff members and students to graduates from industry. Newsletters and a range of relevant career information are also regularly provided to students in a variety of formats including CD-rom, via their careers teachers.

The EAP program is particularly innovative, having the following unique elements:

- Offers workshops in a variety of departments across the Faculty of Engineering (FoE)
- Runs over two consecutive days providing the opportunity for secondary students to be immersed in university life as well as the world of engineering
- Provides additional activities involving female engineering students and representatives from industry
- Focuses solely on Year 10 students who are ready to make subject selections for VCE
- Brings together students with similar interests from a variety of schools
- Targets students from non-English speaking and disadvantaged backgrounds.
- Provides female students with the opportunity to access opportunities and refine knowledge about pathways and career opportunities
- Creates opportunities for secondary students to work with current technologies not available to them in their school
- Provides opportunities for young women to pursue areas of interest where they are motivated

It is worth noting that other programs such as Mentoring Programs are offered at most institutions, including RMIT, to ensure that the academic experience of students who do go on to study Engineering is positive and successful.

Research

In light of the Williams Report, (1988) and qualitative and quantitative studies undertaken at RMIT, it was clear that new programs needed to be implemented if more girls were to consider pursuing an engineering education.

Possible practices being offered in Australia and overseas were considered. By this time over half of university engineering departments reported that they had implemented some kind of special “Women in Engineering” program (Bellis & Armstrong, 1998 p. 27). While a range of strategies had been used, evidence suggested that intense, hands-on, on-campus initiatives

were the most effective in motivating young women to undertake studies in engineering (Hiscocks & Zywno, p.4). A vision was shared by staff from the Faculty of Engineering (FoE) and Community and Regional Partnerships, that this type of program would have positive outcomes.

Implementation of the Engineering Awareness Program

The EAP was first adopted in 1997 and has been implemented on an annual basis since that time. RMIT teaching staff are encouraged to participate in the program. The following discipline areas within the Faculty of Engineering were invited to participate in last years EAP.

- Chemical Engineering (HE)
- Computer Systems Engineering (HE)
- Aerospace (HE)
- Training Centre for Telecommunications (VET)
- Computing and Electronics (HE)

Gaining assistance from engineering students and industry representatives

TAFE, undergraduate and postgraduate engineering students are invited to become involved in the EAP. Student Recruitment is involved in identifying appropriate students and gaining their support. In addition, female graduates employed in the engineering profession also participate. This is mainly organised through RMIT Alumni, and includes past students who have been recipients of equity scholarships and those who have been involved in industry work placements as part of their degrees.

Selection of participating schools and students

Initially, schools are selected for involvement in the program on the following basis:

- Utilising the data base of schools which CIECAP regularly works with on a range of projects, based largely in the inner city region
- These schools have initially been selected in line with the CIECAP brief of meeting gender and equity targets, in response to socio-economic disadvantage and cultural diversity
- Sustainable partnerships have been built with particular school communities and their Careers Advisers, with regular visits to these schools by CIECAP staff.

Letters are forwarded to participating schools outlining the rationale for the program and informing principals and careers advisers of the curriculum to be offered. For many of the schools who have previously been involved this is to renew partnerships and reinforce their understanding of the EAP.
These schools are invited to select between four and six students who will partake in the program. RMIT do not specify any criteria in relation to student selection; this is determined entirely by the school.

The method used to select participating students varies from one school to another. Schools will generally market the program through a feature in their newsletter, and girls who have previously participated may be asked to speak about their experience to Year 10 Girls. The school will then await feedback from interested girls.

Other schools will selectively offer the program to girls who have displayed an aptitude for academic subjects required to do further study in engineering. Girls interested in the program generally remain open about their career choice, or may have expressed interest in the engineering profession.

Teaching Approach

The EAP employs a range of teaching strategies, adopting a student-centred approach, and encourage reflective practice for both teachers and learners. A significant component of the EAP is the provision of a mentoring/peer tutoring approach - a well researched and widely acknowledged means of effectively engaging young people. The teaching approach underpinning the EAP fosters inquiry, discovery, and problem solving modelled through question and presentation skills, providing opportunities for students to develop creative solutions to problems. Experiential learning forms a key part of all EAP programs as secondary students engage in a range of hands on interactive workshops. These teaching strategies enable all students to contextualise their own learning and this in turn develops a framework by which students can establish and identify the relevance of learning beyond their own learning community. Notably, learning is facilitated as a connected whole, rather than as a series of unconnected activities.

Measuring the success of the EAP

Basic quantitative and qualitative research conducted by CIECAP staff throughout 2001/02 indicated the following outcomes:

- Approximately 40% of the students who participated in the first EAP in 1997 were enrolled in engineering courses in 2001
- 75% of students from the 1998 EAP had included engineering in their top three VTAC preferences for study in 2002
- The five students from one school who had attended in EAP in 1999 had listed the following courses as their first preference for university entrance:
    - Engineering/Commerce
    - Commerce/Information Systems
    - Science/Engineering
    - Software Engineering
    - Forensic Science
- One school indicated that 100% of students who attended the EAP in 2000 had enrolled to study physics in their VCE.
- One school reported that the majority of their Year 12 graduates entered tertiary courses at RMIT in preference to alternative universities.
- Students who participate in the EAP often influence others when they return to school. At one school 40% of students who did **not** participate (due to lack of available places in the program) went on to enrol in engineering courses.

- Teachers and careers advisers from secondary schools involved in the program have expressed their on-going commitment to the program and requested additional programs to cater for a greater number of students.

These outcomes are considered to be positive and successful by both CIECAP and the RMIT Equity Unit.

Other Innovations

Briefly, other innovative practices with the objective of increasing the number of girls pursuing a career in engineering include:

- Universities collaborating with secondary school educators by developing curriculum modules which highlight the design process central to all aspects of engineering to be incorporated into science, maths and technology classes (Raytheon/University of Massachusetts K-16 Engineering Collaboration, p. 1).
- Engineering Curriculum developed and presented in schools by female role models (Women in Engineering Programs & Advocates Network).
- Parents involved as support mechanisms for their daughters, including educational workshops for parents (Project 1999: Partnership in Recruitment of Anglo/Minority Girls into Engineering)
- Tours of industrial sites (Project 1999: Partnership in Recruitment of Anglo/Minority Girls into Engineering, 1999)
- Professional bodies taking a leading role in funding and designing programs and activities that will encourage girls to study engineering. For example, The Society of Manufacturing Engineers Education Foundation (based in the US with members from seventy countries) has provided considerable funding to one such program since 1998. The STEPS (Science Technology and Engineering Preview Summer Camp for Girls) is a tuition-free, residential program held across six colleges/universities (SME Education Foundation). This is a national initiative, which aims to grow to cover eleven states reaching 36,000 girls (STEPS).
- Universities in Alberta Canada have come together to establish a science and engineering email mentoring program aimed at girls between 11 – 18 years of age. The program matches these girls with female science and engineering students and women practicing as scientists and engineers. Participating girls are provided with knowledge and motivation from role models through an opportunity to communicate with mentors in a field where there are low levels of naturally occurring mentoring relationships (Scriber Mentor).

Access and Equity
In this context we understand the EAP to be an intervention into the discursive practices of engineering, and while programs such as EAP are not the sole agents of change, the notion of a ‘community of practice’ engendered through participation in the EAP enables discursive changes.

The notion of a community of practices sees the EAP not just as the exposure of girls to a set of experiences otherwise not widely available, but instead as a chance for negotiation and creation of learning experiences, of assumptions, of paradigms that inform identity. In this way of looking at the EAP, the girls, the academics and teaching staff, the facilitators,

postgraduates and the alumni are all practitioners in the creation of a set of possibilities in engineering practice.

By situating the EAP within a Teaching & Learning framework, and by using the model of communities of practice to encourage reflection the EAP becomes a vehicle for exploring the possibilities of engineering activities and identities. We believe that this contributes to the growth and development of engineering discourse, and ultimately of more equitable and sustainable engineering practice.

Recommendations

- That the EAP be aligned with Teaching and Learning and that the EAP program is developed as an elective for undergraduates programs, thus ensuring that the EAP articulates directly to Teaching and Learning across the curriculum, maximising the programs potential to enhance graduate capabilities

- That the EAP continues to target students from socially and economically disadvantaged backgrounds as target equity groups

- That partnerships between industry and the EAP be developed with a view to seeking corporate sponsorship for the Program – this would be done in conjunction with RMIT Development. If sponsorship was forthcoming the number of Programs could increase, the free show bags could include a wider and more appealing range of promotional material, and industry could have a more hands-on role in the development of the EAP in the future.

- That the Engineering Awareness Program continue to respond to feedback from participants in expanding the component of interactive workshops offered in the program

- That we investigate ways of integrating the EAP with the Engineering Mentor Program by using existing student mentors as on-line contact people who may also be willing to visit the schools to talk about engineering

- That the Equity Unit maintain ongoing contact throughout Years 11 & 12 with each of the EAP participants eg by sending information on scholarships, the WIE magazine, Open Day information etc

- That the profile of the EAP is lifted both within RMIT and the wider community, including through partnerships with other universities

Conclusion

While the under representation of women in engineering remains a concern, hands-on, on-campus programs such as the EAP have proven effective in motivating young women to consider this field. The experiences of the EAP in its early years has demonstrated that there are many girls prepared to consider engineering careers given the necessary exposure and encouragement that such programs can provide. In working with young women prior to them entering their post compulsory schooling, the EAP is active in the years when young people

are developing their identities as learners and making critical choices that will influence their future study and career pathways.

Further, the EAP provides a model of community engagement, building links between the university and local learning communities. Such community partnerships are sustained by mutual trust and respect and a shared vision of enhancing and supporting diversity in the engineering profession through addressing the current gender imbalance. Through such an innovative partnership model, the barriers which undermine access to learning are challenged, as are the stereotypes which surround the engineering profession. The EAP is effective in encouraging our potential female engineers of the future whilst it successfully enhances the capabilities of our female engineers and female undergraduates of today.

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