

Embedding EWB Development Projects in an Engineering Program

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***Abstract:** Addressing contemporary global challenges is a key driver for course development within universities. For engineering students, the focus has broadened from building technical capacity to considering issues of engineering sustainability and social justice. Problem-based and service-learning, study abroad and exchange programs are all strategies that enhance students' learning outcomes in these areas. However, in many instances these are one-off events implemented as standalone initiatives during a degree program.*

Engineers Without Borders Australia (EWBA) provides a partnership model for curricula developers to engage students with these concepts. In this paper we describe the implementation and operation of a partnership between EWBA and the College of Engineering and Computer Science (CECS) at the Australian National University (ANU). The operation of the partnership is outlined with specific initiatives that contribute to formal and informal learning, as well as the potential benefits that the community involved in the partnership can glean.

Enriching Education Pathways

The CECS partnership with EWBA provides an opportunity for curricula developers to enrich the education pathways offered to students. There are co-benefits for partners in such a relationship, as engineering programs look to educate graduates with a global understanding of contemporary issues, such as sustainable engineering and community development (Bourn and Neal 2008, Schneider et al 2008, VanderSteen et al 2010), and NGOs such as EWBA seek to obtain community awareness and progress towards their desired outcomes.

Alongside the requirements of both parties is the necessity to deliver an education to students that improves educational outcomes and better engages staff and students. It is well known that active learning opportunities and approaches such as problem- and project-based activities and service-learning result in enhanced educational outcomes for students of all capabilities (Biggs 1999, Shuman et al 2005, Coyle et al 2005). Ramsden (2003) shows that active learning encourages a deep understanding of the material being taught; this is context in which the parties seek to enrich educational pathways in this paper.

In this paper we present a case study of an innovative partnership linking CECS and EWBA that offers enhanced educational opportunities to undergraduate engineers within their formal and extra-curricula (informal) activities. This partnership supports the development of engineers with global skills and awareness and links CECS directly to ongoing community development work. The partnership also encourages academics to participate in the scholarship of teaching and learning that Boyer (1990) emphasised as a vital role of academics in the university environment.

This paper is not intended to be a formal evaluation of the partnership, but a discussion of the factors leading to the formal partnership and the initiatives that have been incorporated to this point in time at CECS, with a formal evaluation to be undertaken at a later time.

Prior Factors Leading to a Formal Partnership

CECS has had a strong engagement with the local activities of EWBA since 2005, with the establishment of the EWBA ACT chapter being driven by a group of PhD students from the ANU. In 2007 and 2008 this engagement increased significantly with the inclusion of the then new EWB Challenge into the first-year *Discovering Engineering* course, with an ANU team reaching the national level in both years. EWB Undergraduate Research was also piloted and driven by a CECS staff member during this time. A school outreach program, including open days and on-campus school visits, that supported CECS outreach activities was also initiated.

By late 2008, EWBA had developed its University Partnership model, specifically aimed at building longer-term relationships focused on curriculum and research opportunities with Australian universities (Smith et al 2010). The design of this model was actively supported by CECS staff and postgraduate students involved with EWBA. An official partnership between CECS and EWBA commenced before the end of 2008 and was renewed at the end of 2009. This partnership enables all of the EWBA initiatives to be supported under a single framework, and provides opportunities for development and trialling of new initiatives.

With the commencement of the partnership, an advisory group was established to drive and manage its implementation. This is chaired by the College Associate Dean for Education, who reports to the College executive, an academic staff member from both Computer Science and Engineering, the Engineering Associate Dean for Undergraduate Education, a representative from student services and marketing, an EWBA staff member and a student representative from the EWBA ACT chapter. This group meets regularly to review the operation of the partnership, highlight and discuss any concerns, and identify new opportunities. The partnership is formalised through an annual memorandum of understanding and a financial contribution from CECS to EWBA.

Current Initiatives Undertaken in the Partnership

The full set of initiatives available through the EWBA partnership model are outlined in Smith et al (2010). In CECS, partnership initiatives are divided into formal, curricula-based activities, and informal activities that do not directly link into the academic program. This is shown in Figure 1.

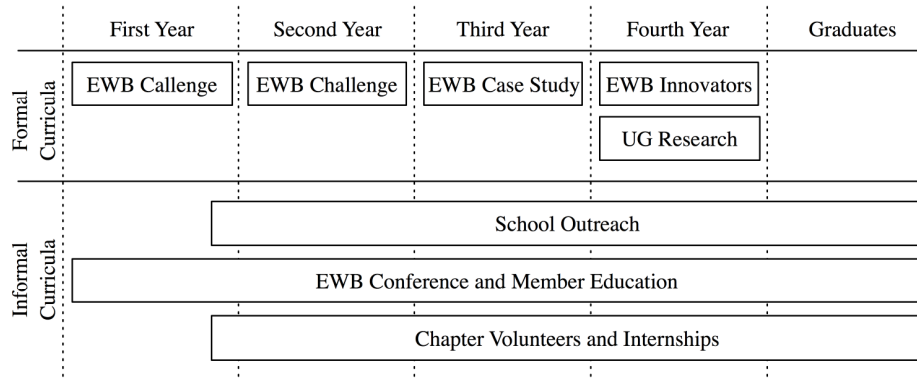


Figure 1: Initiatives undertaken alongside the partnership.

The implementation of key initiatives—EWB Challenge, EWB Case Study, EWB Undergraduate Research, EWB Innovators and School Outreach—will be detailed in the following sections.

EWB Challenge

The EWB Challenge is a first-year design competition offered to universities in Australasia by EWBA. At CECS, it is included as the team project component in the first-year undergraduate course *Discovering Engineering* (ENGN1211). In addition, the second-year course *Systems Engineering Design* (ENGN2225) uses the EWB Challenge design brief to motivate the group project, although it does not extend to being a formal entrant in the EWB Challenge. Both courses can be broadly classed as systems engineering courses and contain material in addition to the EWB Challenge, including guest lectures and supplementary course content.

Anecdotally, the inclusion of the EWB Challenge content in the courses has led students to develop a much broader understanding of their roles as engineers in the wider community. It provides them with a real-world understanding of how, as engineers, they can have a considerable impact on communities, including developing communities nationally and internationally. Authentic problems motivate student outcomes, and this has been observed in both courses as students strive—often going well beyond the scope of the project and their technical knowledge—to develop innovative solutions to the problems that are posed.

EWB Case Study

In the third-year course *Engineering Management* (ENGN3221), an EWBA case study has been utilised to teach project management techniques. The case study has been developed from a real EWBA project that implemented a water delivery system in Tenganan, Indonesia, by a CECS academic. The exercise is delivered in a small group tutorial, and provides a practical demonstration of challenges involved in the logistics of implementing sustainable projects in isolated and culturally diverse locations.

EWB Undergraduate Research

Undergraduate research is incorporated into the compulsory two-semester course for fourth-year engineering students, *Individual Project* (ENGN4221). In this subject, students are encouraged to contribute new work to an area of interest through research under a supervisor by collaborating with an external partner. Eleven EWBA undergraduate research projects have been offered at the ANU since 2007. Students have the opportunity to choose a project from a list supplied by EWBA, or develop their own project based on their affiliations. Projects have ranged from technical analysis of materials for simple ceramic water filtration to scoping studies for large-scale development projects. At the conclusion of the research, findings are made available to the community partner and more broadly on the EWBA website.

EWB Innovators

In semester 1, 2010 an EWBA project option was introduced into the fourth-year course *Systems Engineering Project* (ENGN4221), a capstone course that presents groups of approximately 20 students with a design problem. The brief was to “design an integrated household-level system that improves the health and well-being of Cambodians on Tonle Sap”. Of the seven project options available, the EWBA project was one of the first groups to fill its enrolment, indicating a genuine interest from the student body. Other projects on offer ranged from developing instrumentation to help elite cyclists to designing a Formula SAE car.

The Tonle Sap project posed unique challenges to the students due to the breadth of scope and the unfamiliar culture and lifestyle. A returned EWBA volunteer acted as a technical advisor on the project to overcome the lack of direct community consultation available. This project provided an opportunity to expose the students to such challenges, which are commonplace for engineers working in the field of international development.

The open-ended course encourages students to consider the broader problem, but focus towards chosen areas of interest within the scope, such as simple and resilient technology. The EWB project students undertook to do this, showing a deep engagement with the project. Feedback from students showed that the opportunity to work on a project with meaningful content was a rewarding and valuable experience, and the project was particularly well-suited for a systems engineering approach.

School Outreach

EWBA has developed modules to enhance the awareness of development engineering amongst primary and secondary school students. This program complements events that CECS run to encourage students to study engineering when they complete their secondary studies. The outreach program covers issues such as clean water delivery, solar cooking and climate change, and is delivered through a combination of discussion and hands-on activities.

University student members of EWBA deliver this program to potential students, allowing members to develop public speaking and delivery skills while being role models to school students. This is an informal opportunity for students to further develop graduate attributes and engage in the partnership. Students also have extended this opportunity by further developing existing workshops and introducing new workshops that have been developed by other EWBA chapters.

Further Pathway Opportunities

The initiatives described above are supplemented by local activities and opportunities including:

- *Member education initiatives*, such as the day-long Pathways 2 Development workshop, guest speakers, and the annual EWB National Conference.
- *Training and leadership opportunities*, including the annual three-day EWB National Council for volunteer chapter executives, and the month-long Development Education Experiences (DEE) which are facilitated trips to in-field community partners supplemented by workshops.
- *Volunteer opportunities*, with the local EWBA chapter, such as office interns within the EWBA office hosted by CECS, with the partnership advisory group or with other organisations operating in the community development space.

Example Student Education Pathway

Although the CECS-EWBA partnership is now in its second year, examples are emerging of diverse student education pathways. One student currently in fourth year began their engagement with EWBA by attending a DEE trip to the Philippines at the start of second year. Upon their return, they joined the local ACT chapter and assisted with a number of school outreach presentations. In 2009 they joined the partnership advisory panel as the local chapter student representative, a role they still hold. Over the summer between third and fourth year they returned to the Philippines to volunteer with a local NGO on construction and disaster preparedness, a topic which is subsequently being pursued for their undergraduate research project. Through the partnership they assisted in the identification of the project topic for the EWB Innovators, and took part in the course. This pathway shows the potential engagement and experiences that a student can achieve where a partnership exists.

Discussion of Student Outcomes

The engagements offered through the partnership and with EWBA broadly allow students to identify a pathway to pursue their interests and commitment. The initiatives in this partnership encourage a deep understanding of curriculum content similar to that described in Ramsden (2003) through providing a diverse number of active learning opportunities (Biggs, 1999). Formal and informal initiatives, as shown in Figure 1, contribute directly to learning outcomes and graduate attributes, the importance of which was highlighted by Bourn and Neal (2008) and Sotomayor and Benavente (2009).

Through this combination of aligned formal and informal learning, students have the opportunity to develop enhanced professional competencies in the areas of teamwork, communication, a systems approach, professional and ethical responsibility, and principles of sustainable development outlined in Engineers Australia (2008). Students have shown to have engaged deeply by tailoring projects and activities to their interests, as shown in school outreach, undergraduate research and EWB Innovators.

With a number of initiatives involving external engagement and outreach, the partnership also raises the profile of engineering and its study amongst the broader public. It is hoped this can contribute to an increase in student diversity, particularly female enrolment (King, 2008), and aligns with a number of recommendations and strategies highlighted in the recent Engineers Australia 2010-2015 strategic plan (Engineers Australia, 2010).

Lessons Learned

Upon reflection of the implementation of the partnership, it is worthwhile to note a number of key factors that have made the partnership successful to date. The points listed below are an informal collection of observations that have allowed the partnership to grow:

- Developing student champions that drive engagement with the larger student body
- Identifying academic staff champions that are willing to engage with the content of the partnership
- Consultation with the advisory panel that can consider broader opportunities for engagement, such as discipline-specific academic staff, marketing and student services staff, EWB staff and local EWB students
- Building upon, and offering, multiple initiatives to provide pathways for students to engage in

For any group seeking to implement a similar partnership model, consideration of these factors, as well as the factors identified in the next section, is highly recommended.

Future Directions

2010 marks the fifth year of the EWBA ACT Chapter and the second year of a formal partnership between CECS and EWBA. During this time, the values of EWBA (EWB 2009) have been incorporated into the curriculum, and numerous student projects have been successfully completed.

As the partnership develops, additional activities and improvements to the partnership are expected and are likely to include:

- A focus on IT-related projects to engage Computer Science students
- New curricula opportunities in short overseas courses and field schools
- Evaluating and strengthening existing opportunities
- Recognition of informal and formal learning outcomes by EWBA within a defined curriculum framework
- Establishing a 'learning community' around engineering for sustainable community development. This will likely include interested staff, students and local chapter members, and in the first instance consist of a reading and discussion group (such as that established at Queen's University described by Miller (2008) and VanderSteen (2008)).

2011 is the Engineers Australia Year of Humanitarian Engineering, which provides the opportunity to showcase the options available to students through the EWBA partnership, and how they complement the study programs available in CECS.

Conclusion

The partnership provides a platform for CECS to access engaging course material and case studies, and allows EWBA to engage with a broad cross-section of young engineers. This partnership exposes students to many aspects of engineering that would otherwise be concealed to the majority of the student body. The partnership also provides the opportunity to enhance the experience of students who choose to engage with additional education pathways beyond the formal curriculum initiatives.

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