Paper 63. The Global Dimension in the UK Engineering Curriculum: The EWB Challenge

Emily Mattiussi[1], Dr. Michael Clifford[2] and Dr. Tim Short[3]

[1]Engineers Without Borders UK, London, UK; emily.mattiussi@ewb-uk.org

[2]University of Nottingham, Nottingham, UK

[3]University of Liverpool, Liverpool, UK

Abstract

An ongoing conversation in engineering education studies concerns how best to prepare graduates to face the challenges of an increasingly globalized world, including the twin challenges of world poverty and environmental degradation. This paper describes and analyses the Engineers Without Borders Challenge, implemented at various UK universities in the 2011-2012 academic year. The EWB Challenge is structured as a design project; with first and second year engineering students solving a real-life engineering problem in a developing community – specifically in 2011-12, a community in the Tamil Nadu province in India was used as a case study. Interviews were conducted with academic members of staff who acted as tutors at the universities involved in the Challenge, and these were analysed in the light of historical and contemporary engineering studies and international development research. It was found that, while many involved in the Challenge embraced it as an opportunity to provide a global learning experience for their students, sceptical engineering mindsets were still found amongst study participants, and that this affected the implementation of the Challenge. Recommendations are provided in the conclusion to work towards delivering a Challenge which embraces the global dimension in engineering education and practice.

1 Introduction

In a review of key global trends up until the year 2036, a recent government report concluded that human activity will increasingly fall within the scope of three issues: climate change, globalization and inequality (Royal Academy of Engineering, 2006). Intersecting all three is the concept of sustainability, which will ultimately dictate the type and scope of solutions produced (Bourn & Neal, 2012). These issues will impact engineering in a multitude of ways, and therefore also affect how we prepare and educate current and future generations of engineers.

Development education, aimed at empowering individuals through the acquisition of "knowledge, skills, and values, which enable them to become members of a global community of equals," is a key component of teaching engineers about concepts of sustainability (Boni & Perez-Foguet, 2008). It is being recognized more and more that truly sustainable approaches must be based on respect to cultural freedom, participatory approaches to solution generation, intergenerational equity, and social justice – all aspects of effective development education (Boni & Perez-Foguet, 2008).

This paper presents an analysis of one such example of development education in the UK engineering curriculum. The Engineers Without Borders (EWB) Challenge is an international design programme, managed by EWB Australia and delivered in the UK and Ireland by EWB-UK. By providing participating students with design projects developed in collaboration with partners in developing communities around the world, the EWB Challenge gives engineering students an opportunity to begin to develop the skills and knowledge necessary to address key global issues as outlined earlier. The Challenge was developed by EWB Australia in 2007 and reaches 8,000 students per year at over 30 universities in Australia and New Zealand. The EWB Challenge was officially launched in the UK in the 2011-2012 academic year, and was run for 2,500 students at 13 universities in the UK and Ireland in its second year (2012-2013).

This paper will present the responses of academics and tutors to various elements of the EWB Challenge, and discuss them with respect to observed outcomes of the implementation of the programme in the 2011-2012 academic year, using research conducted on behalf of EWB-UK involving 8 of the 11 participating institutions of the 2011-2012 cycle. It is intended as a contribution to the growing body of literature on engineering for development programmes, including the research conducted on the Challenge over several years in the Australasian context. Opportunities for future work, including alterations to the EWB Challenge, will be presented in the final section.

2 Research Methodology

This section presents an overview of the methodology used for the collection and analysis of data used in this paper.

2.1 Purpose

This paper is a research study based on interviews with engineering faculty at UK universities participating in the EWB Challenge in the 2011/2012 school year. Additional analysis is provided in the form of theoretical frameworks derived from the relevant literature in science and technology studies, engineering and development, and international development. There is also reference to published research on the outcomes of the EWB Challenge in Australia and New Zealand, which is provided for the purposes of comparison.

This paper is part of a wider body of research on the study of how non-technical concepts, such as international development, are represented in the engineering curriculum and how interpretation of these concepts affects their representation. Specifically it relates to the set of literature which describes curriculum reform efforts in engineering programmes through the analysis of specific interventions (e.g., Kabo & Baillie, 2009; Amadei, 2003), including previous analysis on the EWB Challenge as it was run in Australia (Jolly L. , Crosthwaite, Brodie, Kavanagh, & Buys, 2011).

2.2 Data Collection

Interview participants were selected based on their involvement with the Challenge at their respective universities. Participants included women and men, and represented a variety of professional backgrounds and disciplines within engineering. Interviews were conducted with 8 of the 11 universities which participated in the Challenge in the 2011-2012 academic year.

Research was conducted in conjunction with researchers from Coventry University. Semi-structured interviews were employed in data collection, which allowed the interviewers to adjust the pre-existing questions list should they consider it necessary or important to do so (Pawley, 2009). Interviews lasted approximately 1 hour. Additional data was obtained from a 'focus group' at the EWB Challenge Finals, where participating faculty came together to discuss their experience with the Challenge. All individual interviews were transcribed (Pawley, 2009). Quotes from interviews will be italicized in the text in order to distinguish them from quotes taken from other sources.

2.3 Data Analysis

The project employed an abductive research strategy involving the construction of social scientific descriptions from the accounts, language, and meanings of social actors operating in the context of the everyday. The aim of this strategy, according to Blaikie (2000), is to discover "why people do what they do by uncovering the largely tacit, mutual knowledge ... which provides the orientation for their actions" (p.115). A number of other researchers operating in the same subject area as the present study have employed the abductive strategy in their own investigations (e.g. Kabo & Baillie 2009; Riley, 2008; Vandersteen, Hall, & Baillie 2010).

An initial broad thematic analysis was employed after completion of the interviews. This process involved examining the transcripts for explicit and implicit discussion touching on both engineering and international development as well as boundaries/frameworks which delineated the engineering profession in the developed world (Pawley, 2009). Notes written at the time interviews were conducted were consulted in order to allow for some measure of "triangulation" in the analysis process (Pawley, 2009, p. 311).

It is important to note that, because the paper only interprets the findings of interviews with faculty, it does not represent a full-scale analysis of the successes and failures of the EWB Challenge as a programme. Further research into the experiences of students, through classroom observations, interviews, and other methods, would provide a more accurate representation of the effects of the Challenge as a curricular intervention (Seron & Silbey, 2009).

3 Outcomes of the EWB Challenge

The EWB Challenge encourages participating students to engage with non-technical factors of design by emphasizing 'engineering in context'; that is, an understanding of the wider socio-economic, political, cultural, etc. aspects of engineering in order to develop a final design that is most appropriate for the partner community.

With this programmatic aim in mind, the outcomes observed from the implementation of the EWB Challenge can be framed along a spectrum measuring the extent and nature of the inclusion of non-technical issues into the engineering curriculum. At one end of this spectrum is found methods of implementation which wholeheartedly embrace social and contextual issues as essential design inputs. Interviewed academics falling in this category discussed implementing the Challenge in order to advance a certain idea of engineering: "*engineering for…the poorest, for the weakest*" or "*using applied science to [produce] artefacts that achieve social or environmental goals*". In these cases, the Challenge programme was usually backed up by the use of lectures, resources or other learning materials to further emphasize the importance of the social or non-technical aspects of engineering design and practice.

At the other end of the spectrum are modules which de-emphasize the importance of non-technical issues in the design process. This is done implicitly, as through the provision of marking rubrics lacking criteria assessing consideration of social or cultural aspects within the design process. It is also actively done: reports from some universities participating in the Challenge, for example, described how certain tutors involved in programme delivery told their students to focus on technical design considerations, because, ultimately, *"that's what's important"*.

The positions on the spectrum described above demarcate the outer limits of the debate on the role played by the social sciences in engineering knowledge: that is, whether social sciences should play a prominent role in technical design or none at all. In reality, most examples of Challenge implementation fell somewhere in the middle. It is necessary, however, to understand the factors which influence one's position on the spectrum if the aim is to shift the bulk of participating Challenge universities away from the purely technical pole. The following section will examine the responses of individual academics and tutors involved in Challenge delivery, as well as the contexts in which they respond, in order to develop this understanding.

4 Academic Responses to the Challenge

Analysis of academic responses revealed three main categories of response: general knowledge on non-technical subjects, the interviewee's belief in the appropriateness of non-technical subjects for engineers' education, and the wider environment or institutional support for effective implementation.

4.1 Knowledge of non-technical subjects

Bourn and Neal (2012) identify several barriers to the inclusion of the global issues in the engineering curriculum, one of which is limited staff knowledge. They emphasize that this knowledge gap "may constrain the capacity of engineering departments to…bring the global dimension [of engineering education] to life."

In addition to reducing capacity at a departmental level, a lack of knowledge can also affect programme delivery at the level of the individual. This was highlighted by one academic interviewed, who suggested that the lack of knowledge among his colleagues on non-technical topics led, perhaps unsurprisingly, to a *"lack of confidence"* in their ability to teach them. He went on to explain how this manifested itself in the near-exclusive use of quantitative methods in teaching and research:

> *"...some students and staff…understand that in some sense they are working with judgments and qualitative approaches, but... they say 'Oh it's a matrix and we can score it' and suddenly come up with numbers out of something that is purely a case of perception. ...They're taking a quantitative approach, whereas really they should just say 'Well, it is perception, it is judgment,' but then be upfront about the assumptions they've made or how they qualify the approach, and not think 'Oh, that's wishy-washy social science.'"*

The EWB Challenge in Australia has run up against a similar gap in confidence and understanding. Take as an example the Challenge as it was run at the University of Western Australia (UWA), where educators sought out the Challenge initially as a way to improve on student engagement and learning scores from previous years. One of the interventions attempted was a programme designed for the "thorough training of the teaching staff [to be] achieved through a series of…training sessions which included instruction regarding the design process, teamwork, team management and cultural sensitivity" (Stappenbelt & Rowles, 2009). Results were positive: using a scale ranging from 1 (strongly disagree) to 5 (strongly agree), student awareness of "non-technical issues that challenge professional engineers" increased from 3.61 to 4.27 from the previous year's results (Stappenbelt & Rowles, 2009).

4.2 Appropriateness of the Challenge to engineering education

The tongue-in-cheek description of *"wishy-washy social science"* used by the academic in the previous section describes in a phrase a prevalent attitude towards qualitative or social science approaches to technical knowledge by many within the engineering profession. Most academics taking up the Challenge countered this mentality, with the majority of them expressing support for the inclusion of non-technical subjects in the engineering design education. One academic described their reaction to students who did not consider alternative design criteria: "*They know I'll jump up and down because there is nothing worse than someone...saying it was done because it was cheap*."

This attitude, however, is at odds with the observed lack of importance placed on social and cultural aspects at the level of module delivery. Some observations can be made: first, it is natural to assume that the academics interviewed would express positive sentiments about the inclusion of non-technical subjects in the engineering curriculum, as they represent a select group of academics who elected to get involved in the Challenge of their own accord and (as will be elaborated in Section 4.3) generally in the midst of a dismissive or sceptical environment. Perhaps more importantly, it points to the disconnect between the individual at the head of the module in which the Challenge is embedded and those who are more immediately involved in delivery 'on the ground'.

These results show that there is, in some cases, a miscommunication between EWB-UK, lead academics and module deliverers around the aims of the EWB Challenge, and that could be the cause of the outcomes observed. Once again, we find parallels in the Australian Challenge programme, in which tutors were observed encouraging purely technical considerations at the expense of social and contextual considerations in the drive for marks and the bid to win the Challenge competition (Jolly L. , Crosthwaite, Brodie, Kavanagh, & Buys, 2011).

4.3 Institutional support for effective implementation

While the individual responses of academics can affect the implementation of the Challenge programme, a third affecting factor is the context within which these responses take place. Many academics working at the interface of 'traditional' engineering and international development can find it to be a somewhat isolating position, facing pressure and a lack of understanding from colleagues and supervisors at their choice to enter into and promote involvement in this field (Bourn & Neal, 2012). One academic had this anecdote to share:

> *"When I came up with the idea of [using] the EWB Challenge, I went into the Director of Studies meeting to go and present the idea. It got shot down in flames. I was blown straight out of the water. I came out of that meeting with a very heavy heart – '…this is the last thing we need. What we need is more maths. I am very concerned with anything that takes away from analytical subjects...' Then after that they had the review [for programme accreditation] from the [professional institutions] all telling them to include all these things, they all came back..."*

This illustrates the response that many potential Challenge champions receive when they make the decision to include more non-technical subjects in their modules or programmes, as well as illustrating in more detail the mentalities described above with regards to social studies within the engineering curriculum.

It seems clear that it is not only a disregard for 'non-analytical' subjects which causes most difficulties encountered by academics allied to the global dimension of engineering education, and a number of other factors (cost and funding availability being chief among these) affect the decision to implement programmes like the Challenge.

5 Conclusions and Future Work

The Challenge outcomes and academic responses point to a number of interventions which can be made by EWB-UK and its partners to increase the effectiveness of the EWB Challenge. These will be listed below, including steps EWB-UK is already taking in this direction:

1. *Increase knowledge of global issues, especially as they relate to the Challenge, amongst those delivering the EWB Challenge programme:* As previously discussed, teacher training initiatives were implemented with significant improvement in student engagement levels at the University of Western Australia (Stappenbelt & Rowles, 2009). Bourn and Neal (2012) highlight a lack of knowledge as a main barrier to effective implementation of the global dimension in engineering curriculums.

   EWB-UK, through the EWB Challenge, runs training sessions for academics aimed at developing knowledge of global issues. In 2013-2014, it is hoped to link these sessions with other organizations, including professional networks, in order to be able to offer a value-add to our academic partners.

2. *Continue to emphasize the importance of the non-technical aspects of engineering design*: Although it is much more difficult to develop specific interventions tackling perceptions of engineering, there are a number of ways that EWB and its partners can promote an alternative view of engineering.

   By identifying 'traditional' engineering skills (such as creativity in problem solving) that one can obtain from 'alternative' engineering work (such as engineering in developing countries), EWB-UK can ensure that more and varied examples of engineering work are available to students during their degree and that these would have more relevance and thus promote more engagement[1].

3. *Provide support to allied academics through the EWB-UK network*: EWB-UK launched UK-wide Academic Community at the 2013 Research and Learning Conference. The aim of the Academic Community is to enable individuals to embed sustainable human development in the engineering curriculum, and offers support to academics through the Challenge, the EWB-UK Research programme, a guest speaker network, various conferences, training programmes, and materials development[2].

Although implementing the Challenge continues to unsettle traditional engineering mindsets, it is vital that engineers of the future are comfortable with and able to integrate social factors into the design process if their engineering solutions are to make a lasting impression. Continuing to support and critically assess engineering for development educational programmes is an important way of achieving this outcome.

[1] This has been the strategy at Sheffield University, where academics found that an important way of increasing engagement with the students who had no interest in learning about engineering for development work was to relate skills developed on the Challenge with skills that students would need in their future (UK-based) employment.

[2] http://www.ewb-uk.org/academic-community

References

Amadei, B. (2003). Program in Engineering for Developing Communities: Viewing the Developing World as the Classroom for the 21st Century. *33rd ASEE/IEEE Frontiers in Education Conference.* Boulder, CO: IEEE.

Blaikie, N. (2000). *Designing Social Research.* Cornwall, UK: Polity Press.

Boni, A., & Perez-Foguet, A. (2008). Introducing development education in technical universities: successful experiences in Spain. *European Journal of Engineering Education, 33*(3), 343-354.

Bourn, D., & Neal, I. (2012). *The Global Engineer: Incorporating global skills within UK higher education of engineers.* London: Engineers Against Poverty; Institute of Education (University of London).

Jolly, L., Crosthwaite, C., Brodie, L., Kavanagh, L., & Buys, L. (2011). The impact of curriculum content in fostering inclusive engineering: data from a national evaluation of the use of EWB projects in first year engineering. *Proceedings of the 2011 AAEE Conference.* Freemantle: Australasian Association for Engineering Education.

Jolly, L., Crosthwaite, C., Brodie, L., Kavanagh, L., & Buys, L. (2011). The impact of curriculum content in fostering inclusive engineering: data froma national evaluation of the suse of EWB projects in first year engineering. *Proceedings of the 2011 AAEE Conference* (pp. 203-209). Fremantle, WA, Australia: Australasian Association for Engineering Education.

Kabo, J., & Baillie, C. (2009). Seeing through the lens of social justice: A threshold for engineering. *European Journal of Engineering Education, 34*(4), 317-325.

Pawley, A. (2009). Universalized Narratives: Patterns in How Faculty Members Define 'Engineering'. *Journal of Engineering Education, 98*(4), 309-319.

Riley, D. (2008). *Engineering and Social Justice.* Morgan & Claypool.

Royal Academy of Engineering. (2006). *Engineering for Sustainable Development.*

Seron, C., & Silbey, S. (2009). The dialectic between expert knowledge and professional discretion: accreditation, social control, and the limits of instrumental logic. *Engineering Studies, 1*(2), 101-127.

Stappenbelt, B., & Rowles, C. (2009). Project based learning in the first year engineering curriculum. . *Proceedings of the 20th Australasian Association for Engineering Education* (pp. 411-416). Adelaide, Australia: Australasian Association for Engineering Education.

Vandersteen, J., Hall, K., & Baillie, C. (2010). Humanitarian engineering placements in our own communities. *European Journal of Engineering Education, 35*(2), 215-223.