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DON'T FEAR THE ENGINEER: TRANSFORMING CONCEPTIONS AND LIMINALITY

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INTRODUCTION

There are two sides to every coin. Historian Williams (2002) has the following to say about engineers:

> Do [engineers] solve problems? The big problems of the world—a list that commonly includes the fragility of public health systems, globally transmitted epidemics, international criminal networks, disappearing species, terrorism, the global arms trade, and the status of women (and not just in science)—are far too big for engineers to solve by themselves. Engineers may make useful contributions, but they may also be less than useful if they are implicated in causing these problems in the first place, or if they seek tidy solutions when there are none. (pp. 29-30)

This points to the need for interdisciplinary collaboration between engineers and other disciplines and that engineers need to understand and appreciate how people think in other disciplines than their own. However, while Williams' focus is on the engineers there is another side to this coin of interdisciplinary collaboration namely the non-engineers, for example social scientists. Consequently, as much as engineers need to develop some understanding and appreciation for the ways of thinking found in other disciplines, such as the social sciences, non-engineers in turn need to develop some understanding and appreciation of engineering. In this paper our focus is on this other side of the coin.

In our previous work we have explored educational initiatives aimed at creating interdisciplinary environments where students from both engineering and the social sciences can work together, learn from each other and, hopefully, start to appreciate each other's ways of thinking and practicing (Kabo and Baillie 2009; Kabo 2010). In the course *Engineering and Social Justice* (*E&SJ*) both engineering and social science students participated. In interviews with students about their experiences of the course interdisciplinarity emerged as a central theme among the course aspects the students perceived as helpful for their learning (Kabo, Day and Baillie 2009). However, participating in this kind of learning environment can be challenging for students and involve moving into a *liminal space* (Kabo and Baillie 2010).

Prior to this current study we have mainly focused on the learning experiences of the engineering students participating in *E&SJ* (Kabo and Baillie 2009, 2010). However, through our interactions with the social science students taking *E&SJ* and reading their written assignments we realised that many of these students had no or little actual understanding of what engineering really entails and often had quite negative perceptions of it. For example, as one of the sociology students participating in the course put it:

> A good majority of us, and myself, really have no idea in terms [of] talking about engineering. I was going into this course and … actually had no knowledge of engineering. So I was nervous.

Maybe this statement should not be too surprising. In general in contemporary culture one tends to talk more about technology than engineering (Williams 2002). To some extent this is, or at lest has been, true even in the field of Science and Technology Studies (STS) where engineering and engineers have until recently been relatively invisible as focus for inquiry (Downey 2009; Downey and Lucena 2009). Thus, in the social science fields in general students might not be given many opportunities to develop an articulated understanding of engineering. Additionally, when the term 'an engineer' is used outside of academia it can hold many different meanings. For example, in England an engineer can be a train driver while in French one meaning of ingénieur is ingenious person.

Based on the initial student interviews we hypothesised that for social science students no or shallow understanding and/or a negative perception of engineering and engineers might constitute a barrier or threshold for interdisciplinary

collaboration between engineers and non-engineers. Therefore, we sought to study the perceptions social science students had of engineering and engineers while participating in a course together with engineering students on the subject of 'engineering and social justice.'

RESEARCH CONTEXT AND APPROACH

We have described the course *Engineering and Social Justice* (*E&SJ*) in more detail in previous publications (Kabo 2010; Kabo, Day and Baillie 2009) and here we summarise its core characteristics. *E&SJ* was developed and co-taught by an engineering educator (Caroline Baillie) and a sociologist (Richard Day) and was taken by engineering and social science (mainly sociology and developmental studies) students. The course was initially offered at Queen's University in Canada and more recently a variant has been offered at the University of Western Australia. The main aim of the course was to enable both engineering and social science students to consider the current and potentially alternative future of engineering through a lens of social justice. The dominant 'common sense' of current engineering practice as well as alternative practices were explored through seminar style discussions, relevant readings, critically reflective writing and an active community based group project (for example unravelling the complexities of uranium mining on indigenous land).

Author Kabo took part as participant observer during two iterations of the course (at Queen's University) and interviewed students during the first. Three social science students (out of the five taking the course) were interviewed twice about their learning experiences. The interviews were recorded and transcribed verbatim. The following year writing in the form of critical self-reflections on their group projects was collected from the thirteen social science students taking the course (as well as from the engineering students). The social science students' critical self-reflections were then pooled together with the interview transcripts from the previous year and analysed within a framework we have developed combining *liminality* as developed by Meyer, Land and Davies (2010) and *phenomenography* (Marton and Booth 1997). Kabo and Adawi (2011) summarises phenomenography in the following way:

> Phenomenography is based on the assumption that it is possible to describe the ways in which [a group of] people conceptualise a certain concept in a limited number of qualitatively different categories of description. The categories of description are distinguished from one another in terms of the presence or absence of certain critical aspects of the concept. The resulting set of logically related and empirically grounded categories of description is called the *outcome space* for the concept. (p. 287)

In our framework the categories of description correspond to different positions along a spectrum of liminality (a development of the idea of different liminal states proposed by Meyer et al. 2010), as students attempt to internalise transformative concepts. An adaptation of conventional phenomenography, this approach imposes a loose structure to the emerging outcome space beforehand. The idea here is that as learners move along the spectrum, they acquire increasingly complex understandings of the concept under study.

The collected data was analysed with respect to the following issues: how the students perceived engineering and engineers and how these perceptions were influenced by the course. All statements relevant to these issues were collected and read through several times to identify relevant themes, which through several iterations were formalised into *four* liminal positions representing different understanding as well as shifting perceptions of engineering.

RESULTS

Phenomenographic analysis is carried out on a collective level with all student conceptions pooled. Hence our different liminal positions in some sense represent idealised student perspectives, which are illustrated below by statements from actual students. Of the four liminal positions we classified one (A) as preliminal, two (B and C) as liminal and one (D) as postliminal. A visual summary can be found in Figure 1. In the sections following below SI# represents data arising from student interviews and SR# represents data from student reflection documents.

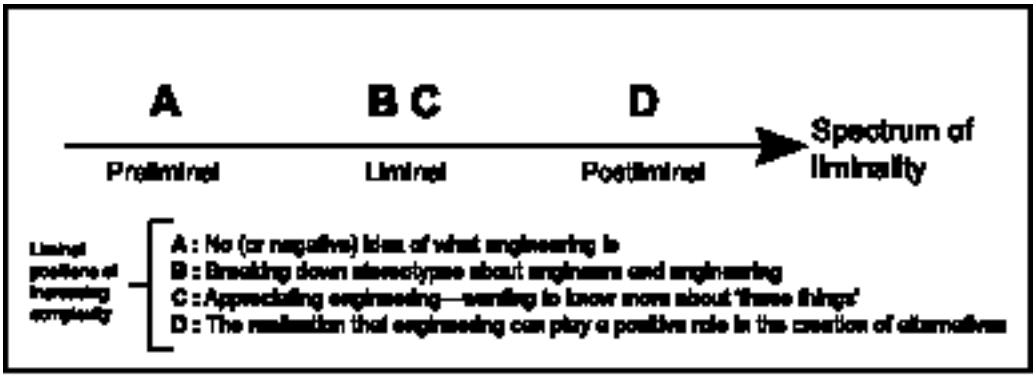

Figure 1. Different perspectives on engineering represented among the social science students participating in the course Engineering and Social Justice.

PRELIMINAL POSITION A: NO (OR NEGATIVE) IDEA OF WHAT ENGINEERING IS

> **SR18**: I remember when I first came into this class, I had no idea of what 'engineering' actually was, beyond the chants we sang about engineers who should 'go build a bridge and jump off it.'
>
> **SI10**: I used to think that engineers had no social skills but this course has proved otherwise.
>
> **SI8**: I thought that all engineers wouldn't be able to have any critical thinking skills or be able to reflect because they ... go to class, sit in lectures, take notes, read a text book, study it, memorise it, and write it out, so they never question materials so that they wouldn't have those critical thinking skills as individuals.

As indicated by the statements above, which are all in the past tense, this position does not represent an active perspective in the classroom, but rather from where some of the social science students started. As the student statements reflect no or stereotypical understanding of engineering and engineers we have classified this as a preliminal position.

Liminal positions: Shifting positions about engineers and engineering practice

POSITION B: BREAKING DOWN STEREOTYPES ABOUT ENGINEERS AND ENGINEERING

> **SR18:** In some ways, my definition of what engineers do has become even more confused, but in others I've grasped the breadth of knowledge and expertise that engineers bring to their own field of study, which happens to be as or nearly as widespread as the liberal arts programmes. Along with this diversity, I have also began to recognise the difference among each engineer I've gotten the chance to know—it turns out they aren't just one big group of partying, conservative, clones after all!
>
> **SI10**: I think a lot of people [engineering students] are very well spoken and come across as extremely socially intelligent people so ... a lot of my preconceptions have definitely been taken away which is probably a good thing.
>
> **SI8**: I did have preconceived notions about your typical male engineering [student], sort of not very considerate, very much just in with the work that they were doing, and more boyish and immature, but it's not true. The guys that I worked with were critical thinkers, they were gentlemen, they were socially conscious. They weren't perfect by any means, but they were complete, they were really kind, really amazing people and I think that it was really important for me to sort of break down to work with them and get to know them past my classmates and as friends and yeah I think they were amazing.

For the social scientists, the course offered an opportunity to work with engineering students in a constructive manner that in many cases resulted in the breaking down of (negative) stereotypes of engineers and engineering. This is an important first step toward grasping any positive potential engineering has to offer. As the student perspectives represented here reflect beginning to revaluate and expand one's understanding and view of engineering and engineers we have classified this as a liminal position.

POSITION C: APPRECIATING ENGINEERING—WANTING TO KNOW MORE ABOUT 'THESE THINGS'

> **SR6**: One of my proudest moments of the project was when I could stand in front of our entire class and discuss the intricacies of load-bearing walls and feel (somewhat) legitimate doing so! This project has definitively sparked an interest in wanting to learn more about 'these things,' as well as a new appreciation for the art of engineering (who knew you needed cement to hold a post in the ground!?).

This liminal position also represents beginning to revaluate one's understanding of engineering, but here the keyword is appreciation. The position is also differentiated from position B due to the more personal perspective on engineering knowledge in terms of confidence and wanting to know more.

Postliminal position D: The realisation that engineering can play a positive role in the creation of alternatives

> **SR14**: Participating in this class this semester has definitively been an eye opening experience. I came to the class thinking I knew what 'social justice' was and how it should be approached. However, I have come to realise that social science students are often given the tools to deconstruct an issue, but have no ability to directly apply it in the real world. Working with engineers has most definitively created and developed this balance. Overall, this class has taught me not only to think but to think and act.
>
> **SR2**: … during this idea generation stage I realised that there will never be a perfect option, however unlike in sociology where one can simply deconstruct—engineers are trained to construct. Therefore I had to force myself from rejecting every idea that was suggested and try to decide on one that seemed like the 'best' option.
>
> **SI10**: Before I was very critical, sort of talked from a perspective that everything is bad, science [and engineering] is bad. All they want to do is take over the world and earn lots of money. … [The course has] made me more aware that there are positive aspects within that as well that can be very helpful and very useful. I mean there are a lot of things that technology does for us that is very useful, it just a matter of not always taking it for granted or just accepting everything that we are sort of presented with as necessary so…

Some social science students moved beyond the breaking down of negative stereotypes or emerging appreciation for engineering to the realisation that engineering can play a positive role in the creation of viable alternatives to current practices and that engineers possess skills and ways of thinking that complement those of social scientists in a potentially beneficial way. This represents a much more complex perspective than the previous three positions and we have thus classified this as a postliminal position. This is the state we want students to reach.

CONCLUSIONS

Our findings indicate that understanding engineering and engineers can serve as a threshold that social scientists students working in an interdisciplinary context with engineering students need to cross for the possibility of true interdisciplinary, rather than multidisciplinary, collaboration to take place. A central aspect of this crossing is to negotiate together with engineers what engineering means and can mean. The four liminal positions indicate that it is possible to shift non-engineers' perceptions of engineering and its potential from ignorance to more complex understandings. On a collective level we can see shifts from social science students believing that engineers are uncritical, with no social skills (preliminal), to an appreciation for engineers and engineering (liminal) and finally to a postliminal position realising that social scientists can deconstruct and engineers can build alternatives and by learning from each other and working together much can be gained.

Based on the findings presented above, the conclusion can be drawn that the course studied is capable of shifting the perceptions of engineering held by social scientists in ways that can provide a common ground for starting to work together with engineers to address some of the pressing challenges facing humanity. But this is just the beginning…

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