Practice and Evidence of Scholarship of Teaching and Learning in Higher Education
Vol. 4, No. 2, October 2009, pp. 126-146

Engineering and Social Justice: How to help students cross the threshold

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Abstract

This paper reports on the interdisciplinary course "Engineering and Social Justice: Critical theories of technological practices" developed and first taught at Queen's University, Canada, by Richard Day (Sociology) and Caroline Baillie (Engineering) in 2006 in order to bring engineering and social science students together to help them develop critical thinking in relation to engineering practices while questioning common assumptions. This process was focused through a social justice lens that the students were encouraged to adopt. However, this was not easy to do for many of them and can be likened to the crossing of a threshold. In this paper, we explore the conceptual framing of the course as well as some of the crucial parameters of its apparent success in guiding students across the threshold.

Keywords: engineering, social justice, critical thinking, interdisciplinarity

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ISSN 1750-8428 (online) www.pestlhe.org.uk

Introduction

Most engineers would agree with the basic idea of themselves that "We are engineers, we solve problems" (Williams quoting Provost Robert Brown of MIT, 2002, p. 29). But Williams asks of us:

> Do [engineers] solve problems? The big problems of the world … 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. (Williams, 2002, pp. 29-30)

Catalano (2006, 2007) identifies two of these problems as the challenges of poverty and environmental sustainability and argues that engineers need to work to amend and not worsen them. However, if we are to heed Williams warning about the limits of engineering problem solving we need to consider how a balance can be found where engineers can contribute in a positive way towards lessening the world's most pressing issues without being blinded by their belief in the infallibility of engineering. Williams is not the only one expressing concern and critique of the traditional approach to engineering problem solving. Others include Baillie (2006); Reader (2006); Bhatia and Smith (2008); Riley (2008); and Zoli, Bhatia, Davidson, and Rusch (2008). Riley and Baillie, in particular, have attempted to address these issues directly with students in order to facilitate the development of engineers in the future who have a more holistic view of problem definition and problem solving.

The course we report on in this paper is one such attempt. Baillie, who is an engineering professor, and Day, who is a social science professor, laid the foundation for the interdisciplinarity that is a cornerstone in the course. Baillie had the idea that it should be possible to analyse engineering in the same way as has been done with science and technology (see Baillie & Catalano, 2009, pp. 13-27, for examples). The tools to do so were what were needed. Baillie asked the following questions: What is engineered? Who is it engineered for? What happens inside engineering organisations? Is it equitable? Does engineering have to contribute to capitalism to the extent it does, even at times driving the extreme forms that are notable in some multinational organisations? These questions guided the design of a course where engineering and

social science students come together to develop critical perspectives. These are ways of seeing beyond taken for granted "common sense" (Gramsci, 1971) perspectives toward technology in general and engineering practice in particular. Students also explore alternative ways of relating to technology that are non-capitalist and non-oppressive. That is, they come to challenge the dominant Western world view that capitalist technologies are somehow "neutral", to see how they are often based on the domination and exploitation of both human beings and the land. This is apparent, for example, in the global division of labour that locates high-paying, high status, "safe" and relatively non-polluting activities (such as design work) in the global North, while relegating to the global South dangerous and low-paying jobs (such as assembly) to unregulated factories in the so-called "developing" world. In the course this process is focused through a critical social justice lens. The course fits into a wider tradition of "critical pedagogy" or education centred around social justice, which dates back to Freire (1970). Bell (2007) captures the essence of this tradition:

> The goal of social justice education is to enable people to develop the critical analytical tools necessary to understand oppression and their own socialization within oppressive systems, and to develop a sense of agency and capacity to interrupt and change oppressive patterns and behaviors in themselves and in the institutions and communities of which they are part. (Bell, 2007, p. 2)

In this paper, we explore the conceptual framing of the course as well as some of the crucial parameters of its apparent success.

The course "Engineering and Social Justice: Critical theories of technological practices"

The course is a second level elective open to engineering and social science students of years 2, 3 and 4. As the reputation of the course developed the percentage of social science students (to almost 50/50) and the numbers of students taking the class increased (to a cap of 30).

The What

The two main approaches of the course were the deconstruction of the "common sense" of current engineering practices and the creation of alternative practices which are non-oppressive, non-capitalist, and ecologically sustainable. These themes were explored through weekly readings and other media such as film clips and guest speakers. As well as exploring basic definitions of social justice and engineering, the course started by introducing the students to key concepts related to the social construction of technology (society shapes technology) and technological determinism (technology shapes society). The dominant engineering paradigm of technological and capitalist rationality was explored and critiqued from its rise during the Industrial Revolution to its current phase of neoliberal globalisation. Neoliberalism, according to Riley (2008), is "capitalism that places ultimate faith in private property, free markets, and free trade, privatizing industries and lifting any government protections on trade, the environment, labour, and social welfare" (p. 7). Globalisation in this context refers expanding these ideas beyond the Western national state to a global market. Towards the later part of the course, alternative paradigms were explored through a series of lenses such as anarchism and feminism.

The How

The class met once a week for a three hour seminar. Both instructors were present at all times. This enabled the students to see difference in ways of thinking in action and made them feel more able to question terminology or concepts that they did not understand. Each class was split into two sessions usually focusing on different topics and readings with one of the instructors taking the lead for respective sections. Often the instructor leading would give a short introduction to the topic at hand and then open up the floor for class discussion. Alternatively, a film clip or a guest speaker would introduce the topic. The discussions were the main dynamic of the classroom through which the week's topics were explored, but at times this was mixed up with small group exercises. In addition to participating in the discussions the students engaged with the course themes by writing two critical response essays and carrying out community based group projects (in which they were to critically examine elements of engineering practice). These essays were of crucial importance to the development of the students' thinking. Individual and deep feedback was given by each instructor to each student –

hence two sets of feedback. The students progress was discussed by the two instructors and interventions created to facilitate learning in difficult areas. For example, after the first essay it was decided to alter the focus of the second. In this new and slightly revised assessment task, the engineering students were asked to "only deconstruct" and the social science students to "stop deconstructing and to create alternatives".

Hypothesis and study of the course

After the first iteration of the course in 2006 Baillie noted that students taking the course appeared to move into what Meyer and Land (2005) refer to as a *liminal space*, which is a "space" of uncertainty, flux, and transition between two different states of knowing, being or seeing. Some students were able to apply a critical social justice lens in discussions and assignments, i.e. they were able to pass though the liminal space and were able to reach the desired course outcomes. Other students had difficulty changing how they thought about engineering and technology and to adopt alternative views and could be said to get stuck in the liminal space. Yet others (the majority) tried different ways of approaching adopting social justice as a critical lens and can be said to have been moving back and forth in the liminal space uncertain of how to pass through. Clearly for most students in the class it was not trivial to start thinking about engineering in terms of social justice. Drawing on Meyer and Land (2003), Baillie hypothesised that for engineers, both practising and students, adopting a socially just perspective to their practice and profession could be seen as a threshold that needs to be crossed and that this transition might prove both transformative and troublesome. As a 2008 engineering student put it:

> S13*: This course has had a huge effect on my way of thinking. Big time! … It really messed with my head. Sometimes I was scared to go to class because I didn't want to think about stuff … I feel now that I look at things from a different perspective or CAN … I feel I'm going to think more socially about making certain decisions. But I think it could have an impact on my success within a company ... (SIGH) this course... [Kabo: A bit scary...?] Yeah most definitively!*

In order to understand what could be done to help students navigate this liminal space in future years and to better understand how the course shifts the students' perceptions of engineering and social justice Kabo and Baillie studied the course in depth during

2008 and 2009. Kabo took part in the class as a participant observer both years, conducted interviews in 2008, and analysed student assignments in 2009. An adapted phenomenographic (Marton & Booth, 1997) approach drawing on Threshold Concepts Theory (Meyer & Land, 2003, 2005) was utilised. Phenomenography is based on the assumption of a non-dualist position (where student and teacher negotiate knowledge together rather than one passing knowledge to another), and facilitates the creation of an "outcome" space of shared conceptions of some phenomenon. In our case these conceptions correspond to positions through the *liminal space*. In this way the variation present among the students in the class as they attempted to approach adopting social justice as a critical lens could be mapped. The approach is explained in detail in Kabo and Baillie (2009a). Part of our findings have been reported elsewhere: Kabo and Baillie (2009a) explore the students' conceptions of social justice; Kabo and Baillie (in press) explore the proposed social justice threshold in more detail and highlight engineering "common sense" as a major barrier toward adopting a social justice lens; and Kabo and Baillie (2009b) focus on shifts in students' perceptions of engineering. In this paper we focus on how the ways in which students perceived the course helped them approach the adoption of social justice as a critical lens. The data have been drawn from 14 student interviews from 2008 and 30 self reflections from 2009.

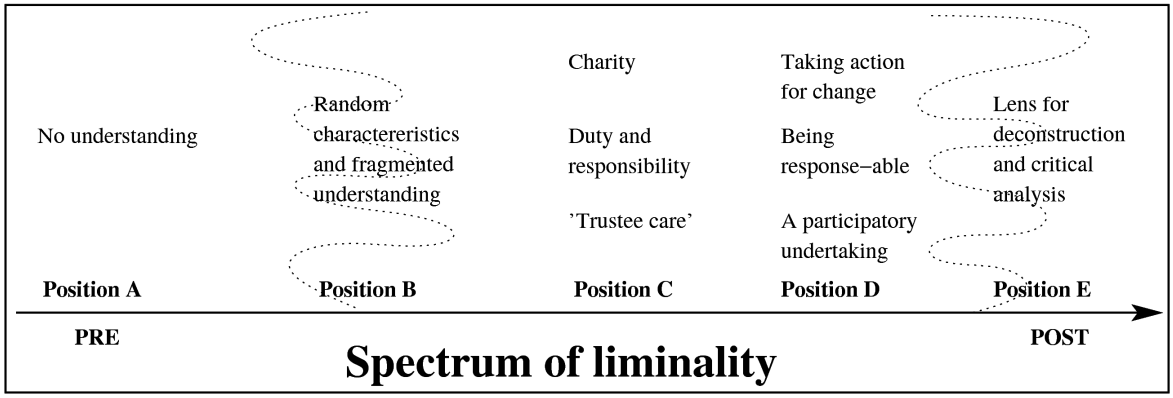
The course works

Based on our previous research we can conclude that the course is successful in helping some students shift their thinking about engineering and approach using social justice as a critical lens. Here we give a short summary. In terms of students' conceptions of social justice, we found nine different conceptions of varying complexity ranging from little or no understanding to using social justice as a lens for deconstruction and critical analysis (which has been repeatedly stated to be the aim of the course) (Kabo & Baillie, 2009a). A visual summary can be found in Figure 1.

In terms of shifts in the students' conceptions of engineering we found two separate outcome spaces for the engineers and the social scientists (Kabo & Baillie, 2009b). A summary can be found in Table 1.The main theme emerging for the engineers was deconstruction of current engineering "common sense". The main theme emerging for the social scientists was the revelation that engineering can in fact play a positive role in the creation of viable alternatives.

Figure 1 shows a visual representation of the nine conceptions of social justice discerned in the class clustered together into five groups, which form different positions of increasing complexity on a spectrum of liminality – going from a pre-liminal state (the threshold comes into view) to bordering on a post-liminal state (exiting the threshold) (Kabo & Baillie, 2009a). As educators our aim is to shift students toward more complex conceptions. This is not a linear process as students will navigate their journey over the threshold along different paths and can hold multiple conceptions at the same time.

Figure 1. Increasingly complex conceptions of social justice



In table 1 there is a summary of the two outcome spaces of shifts in how engineering respective social science students thought and talked about engineering as a result of the class (Kabo & Baillie, 2009b). Generally, the engineers shifted away from technological and capitalist rationality toward deconstruction and re-evaluation of their understanding of their future profession. The social science students generally shifted from a vague and often negative view of engineering toward a more complex understanding where the potential of engineering were seen in a more positive light.

Table 1. Shifts in student's perceptions of engineering

Shifts in How Engineering Students Perceive Engineering
A – Critique of the hegemony of engineering education
B – Critique of the hegemony of the current profit paradigm of engineering
C – Critique of the notion of a "right answer"
D – Critique of the "common sense" of technical solutions
E – The need for engineers to be humble and open for critique
F – The need to ask who do we as engineers engineer for?
G – The world is confusing and how do we as engineers fit in?
Shifts in how Social Science Students Perceive Engineering
α – Breaking down stereotypes about engineer/s/ing
β – The realisation that engineering can play a positive role in the creation of alternatives

Key characteristics of the course

Our research also indicated what the key features were that helped to promote the above shifts. [The following notation has been used below: S# - represents a student interviewed in 2008, SR# represents a student self reflection from 2009, ENG – stands for engineering, DEV – stands for developmental studies, and SOC – stands for sociology.]

Mix of students from different disciplines

The idea with bringing students from such different disciplines as engineering, sociology and developmental studies is that they will learn from interacting with each other. For most students it was a novel experience to share a classroom with people influenced by the thinking of a radically different discipline and this encouraged them to expand their horizons. Here is what two students had to say:

> S14 [ENG]: *I loved that there was a mix … I would love to see more interaction between engineers and sociologists, but again I wouldn't want that sort of thing imposed, … but I wanted more of it to happen just because it was so interesting. When we were working with S8 … she was the only non-engineer in the group and … she just thought of things very different than we do*

and I really liked that and would have liked to see more of that.

SR12 [DEV]: *The most valuable aspect of the course was the opportunity to interact with other students coming from very different backgrounds, especially the engineering students. I found the in-class discussions very interesting, especially as students with different perspectives tried to understand each other and communicate their interpretations of subject matter. … the opportunity to work together and question our assumptions of what we think we know.*

Two instructors present at all times, with the ability to respectfully disagree with each other

The course was co-taught by two instructors from different disciplines. This helped to facilitate communication over the disciplinary borders since the engineering professor could act as "interpreter" for social science terms, unfamiliar to the engineering students and vice versa for the sociologist with technical terms.

Kabo: *The most fruitful part of what's happening in the classroom?*

S2 [SOC]: *The discussions definitely, you learn from each other, right? ... I like the fact that [either of the instructors] talks and then opens it up for discussion because then they … also reconsider and ask what they [the other instructor or the students] are saying so anything that wasn't clear cut before is cleared up through the questions that the class brings up.*

In addition, the instructors are people with open minded attitudes willing to critique themselves and each other. So the students knew that disagreement was OK as the two instructors could argue with each other and take different positions during discussions. This resulted in that the idea of the existence of a "right" answer was challenged.

S14 [ENG]: *[The course] taught me that my opinions and my ideas don't necessarily have to be right or wrong as they very often are measured and considered in engineering – right answer, wrong answer – and it's just very weird to think: Oh! here's an idea and that's all it is, … it's not an answer or right or wrong or ... you could judge it accordingly.*

Small class size and seminar format

Freire (1970) made the distinction between what he called banking (passively being told the "right" answers) and problem-posing (actively finding answers through dialogue)

education and how the later is more appropriate for helping learners successfully engage with topics such as those covered in the course. Drawing on this the course was run as a seminar focused on active participation and the classroom was set up to facilitate this.

> Kabo: *What do you think of the course format? The sitting in a ring and mixing up with everyone?*
>
> S6 [ENG]: *I think it is good, I don't know how you could better organise a course like this. Everybody get to face each other and see the person that is talking, it is not like the lecture where everybody is facing forward to the front.*

In addition to a classroom which encourages interaction, a small class size is crucial since it becomes impossible to have a meaningful discussion with too many participants involved. Also, as students are moving into risky territory, it is important to be able to "hold" their fear. This cannot be done in a lecture theatre.

> S9 [ENG]: *I am glad I took the course. I think it's an important course and … I wish everyone would take it in engineering but ... then you'd have to go to lecture style of this is "engineering and social justice" and then one wouldn't take it seriously so…*
>
> S6 [ENG]: *This is a course that wouldn't be very good if it was a lecture. You need the discussions.*

A respectful learning environment

Drawing on the work of Ellsworth (1989) and hooks (1994) another important aspect of the class was to create a respectful learning environment where students had the autonomy to explore and engage with the themes of the course through their own agency. The instructors did not tell the students what to think, but encouraged them to come to their own conclusions through the use of open-ended and probing questions. However, while the instructors knew how to do this respectful, but probing dialogue, the discussion dynamic between the students in the class was not always as smooth or beneficial.

> S10 [SOC]: *I feel that opinions are really respected when people put up their hands and they're asked to talk, I feel like everyone is very respectful … but I do find it [discussing with engineers] intimidating just because a lot of people seem to have this very dominant and clear view of how*

> *they think things should be … I find it very challenging to construct an argument that is a counter argument in the convincing way, and I find that some people have such a … they made up their minds so clearly.*

Taking a position over expressing an opinion

Yet another important aspect was that most of the time the students were encouraged (and in their writings required) to take a position rather than only state an opinion. Day explains the crucial difference between these two:

> *An opinion is not necessarily informed by any knowledge of the matters upon which one is opining. Anyone can have an opinion about anything. Opinions cannot be refuted, i.e. they can contradict other opinions without difficulty, since there is no shared basis for discriminating between them.*
>
> *Taking a position, on the other hand, means having at least some knowledge of that about which one is speaking, and especially of what others have said in the past, and are saying now. We could say that taking a position means precisely showing that one knows what other positions have been, are being, and could be taken. This shared background is what makes it possible for positions to be compared, contrasted, evaluated.*

To stimulate this in the classroom the instructors would often follow up a student statement by asking: What do you mean by that? This invited the students to think about their taken for granted assumptions.

> S1 [ENG]: *[the instructors] are always questioning in terms of what we're handing in and everything ... [e.g.] Is this socially just or just charity? I think that constantly being asked that question is very helpful in terms of defining social justice and now because of that … anything that gets drilled into you, you keep on thinking about it. So it's good.*
>
> Kabo: *So the constant questioning makes you …?*
>
> S1 [ENG]: *Yeah, sort of routine to think about that in day to day life. There are definitely cases now where I'll be thinking: Wait a second!*

Large range of media and intervention

The course readings covered a large range of topics and perspectives from texts

praising technological development to texts dealing with anarchism or feminist perspectives on technology. For examples of course readings see: http://engineeringjustice.wikispaces.com/. The idea was to make the students understand the complexity of the topics and again that there might not be one right answer.

> S2 [SOC]: *Every week is something different, right? So the ideas were definitely broadened by that and the questions that people ask broaden it ... it's just you go into it further and you learn that through interacting*.

In addition to different readings, variation and diversity in perspective and ideas were also expanded on by the use of video clips and presentations by guest speakers.

Topics seen from many perspectives with the potential of debate

An example of a video segment that sparked a lively debate in the class was the Seattle police's forceful handling of peaceful demonstrators during the World Trade Organisation's (WTO's) meeting in the city in 1999. While this example did not explicitly relate directly to engineering it was a great example of what Ursula Franklin (1999), who the students had read, refers to as a culture of compliance. Here is how two students reflected on the film clip and the following discussion:

> S3 [ENG]: *Many engineers in the room were shocked by what was going on. If you buy into everything that's engineering then you have a hard time to agree with the protests.*
>
> Kabo: *How did the engineers react?*
>
> S3 [ENG]: *For example they called the film biased. Yeah it was biased but was unapologetic about it and let it show.*
>
> S8 [SOC]: *So for instance when we were talking about the WTO protest riots in Seattle and about the police using physical force on the protesters. A few of the classmates said: Well they deserved it. And then, of course, you have this uproar between people who are like what do you mean they deserved it? … we get into discussions where people are going to disagree with one another, but that's the best part ... because I feel that change can only come from this kind of conflict and people thinking about it afterwards.*

Real issues and guests

As an example of how a guest speaker engaged the class, Nasser Saleh, Queen's University's Integrated Learning Librarian, spoke of the potential of Facebook™ and similar web communities for social justice movements, but also of who owns what on the Internet and the potential dangers of monopolization of virtual social spaces by private interests. This gave the students an issue that was relevant to many of them on a more direct level than, for example, Marx's writings about commodities.

> Kabo*: Do you remember any part of the course … that sticks out?*
>
> S6 [ENG]: *The main thing that stands out for me is communication technologies because ... we read a of lot stuff by Ursula Franklin and … we were discussing about the impacts of communication technologies on societies. For example, Nasser gave a talk about Facebook™ and our project is all about communication technology and its impact on social movements in Kingston. So what stuck out to me the most [was] discussing how these technologies are affecting our lives and our societies and everything.*

A topic that was focused on through the use of film and by a guest speaker was the recovered factories of Argentina. This was a concrete example that challenged the students' notions of people's goals and how industry works and showed them that there can be alternative business models than those they were used to from a North American context.

> S7 [ENG]: *I found it really inspiring that people had proven that if you want to make a living, you know these people aren't making profits per se, I mean obviously they are but they're not answering to shareholders every quarter and coming up with bigger and better numbers. They're just making enough to feed their family … I really want to imagine that these people really don't want more than just to live lives that are free from hunger … it's hard to imagine at least in my mindset that that's actually true ... but at the same time it's very inspiring to see that humbleness and the idea that you could work for something because you need to eat, but not have this bigger and better goal. Yeah it's hard not to say those kind of things, but have this greater goal of having more than you know the Smiths next door.*

Relevant community based group project

An important aspect of the course was the use of relevant (interdisciplinary) community based group projects focusing on issues such as uranium mining on land claimed by

indigenous people. As an example, in this particular uranium project the students were introduced to a situation arising from discrepancies between federal and provincial law that resulted in the starting of mining operations without consultation of the indigenous people claiming the land which usually is the norm. The students had to unravel a complex web of stakeholders and attempt to understand what was going on by conducting interviews and surveying literature and legal documents. They ended proposing that the information they gathered could be used as a case study highlighting the complexities surrounding engineering practice. Like in most cases, this project team consisted of students from both engineering and social sciences. Thus, the projects served as microcosms where students from different disciplines came together to learn from each other and break down stereotypes.

> S8 [SOC]: *A lot of people have preconceived notions of the typical engineer, the typical arts student and I think it was amazing to break that down and realize a lot of those preconceived notions are bullshit … It was really great to move out of that and I did have preconceived notions about your typical male engineering … I think that it was really important for me to … work with them and get to know them past my classmates and as friends and yeah I think they were amazing.*

In addition, the projects gave the students something “concrete” to which they could relate the topics of readings and classroom discussion.

> S8 [SOC]: *I learned a lot from the project … You put in the dynamics or the things that you talk about in class and social justice and working together and community building and local initiatives and engaging with your world as a community … I talk about that kind of stuff all the time but to actually work within a group and look at an issue that’s actually facing people today really shows me that if people do get together and work then little things can be done to help promote justice.*

The projects also allowed the students to engage with a “real” social justice issue which made the learning experience more personal.

> S7 [ENG]: *I think it’s important the projects happen because it gets your hands dirty and really makes you realize that we’re talking about people being oppressed as a result of this or left out as a result of that. And you know we go and interview people I think it might give us the opportunity to realize who that is and give a face to these ideas … But, now if you’re sitting in someone’s house and they’re telling you that they just can’t afford the Internet and as a result you know they couldn’t use these services with their telephone provider, they couldn’t do this or they couldn’t do*

> *that or they can't talk to their granddaughter because she doesn't like writing letters you know. I think that's when you really have to face those issues and come to terms with them somehow.*

The projects offered different challenges for students of each discipline. The social science students were not used to working in group projects, but often had knowledge of required methods and some awareness of the issues at hand.

> Kabo: *have found anything in the course challenging?*
>
> S2 [SOC]: *The project is challenging I think, because … I'm not used to being in project groups and then making time. I'm just so used to this is your essay make your own time to write it, schedule it. I like scheduling when I'm gonna do what… with projects you never know, you have to change your schedule and make it work for everyone … working with people I guess.*

The engineers on the other hand were used to work in projects but often lacked the required knowledge and awareness.

> SR1 [ENG]: *I found the project to be a tremendous learning experience. To be perfectly honest, when I first tried to do some work I was completely at a loss for how to proceed. I looked at material from other design projects I've done and tried to emulate the same process, but in a lot of ways I found it breaking down. Some of the concepts just didn't apply to projects of a social nature and even the ones that did seemed not to get me anywhere useful.*

Thus suitable project teams included people from both disciplines. The students were free to choose the projects they wanted to work on but were encouraged to mix across the disciplines and most project teams were mixed. Overall, the projects were positive experiences for many students.

> SR6 [DEV]: *When I first found out that I would have to be part of a group project involving engineering my first thought was, I hate group projects! My second thought, a little more disconcerting, was what can I ever contribute to this project? Three months later I can honestly say that this has been one of the most enjoyable assignments of my university career thus far, and definitively one of the most beneficial for my overall growth as a student. I cannot say enough about the three guys that I worked with on this assignment – they have changed my perspective on group projects drastically.*

However, there was a trend in some of the project teams to split tasks up in accordance with disciplinary skills to better deal with a heavy work load and consequently for some

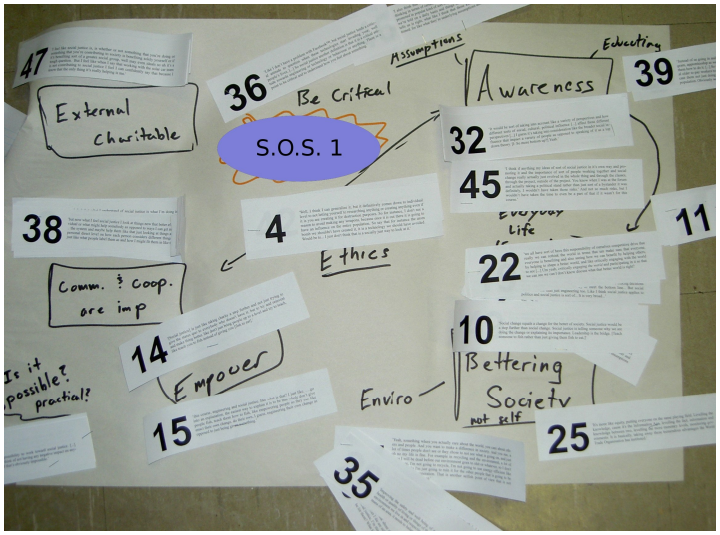
students the project did not help their understanding of social justice in any major way.

> Kabo: *Have you found it useful to have the project in the course?*
>
> S4 [ENG]: *As a tool to making me aware of that?*
>
> Kabo: *Yeah, or how to deal with the issue.*
>
> S4 [ENG]: *For me I'd say personally not, but I'm again doing the more technical stuff. The seminars I prefer more, but I'm sure that these people might have more to say.*

Variation theory: Incorporating the results of research

In a previous publication (Kabo & Baillie, 2009a) we suggested an exercise drawing on the outcome of that study. A version of that exercise was implemented in the 2009 iteration of the course. The main idea was at an early stage of the course expand the students understanding of social justice by having them see it through the eyes of other students. This was done by having them in their project groups read trough a selection of quotes about social justice from the interviews with the previous year's students. The quotes, numbered 50 in total, corresponded to one of the nine categories/conceptions seen in Figure 1. Except for a few which had not been assigned to a category. The rationale, drawing on variation theory (Marton & Tsui, 2004), was to expose the students to variation in how social justice is understood by someone in a similar context as the students themselves.

Figure 2. An example of a student outcome space (S.O.S.)



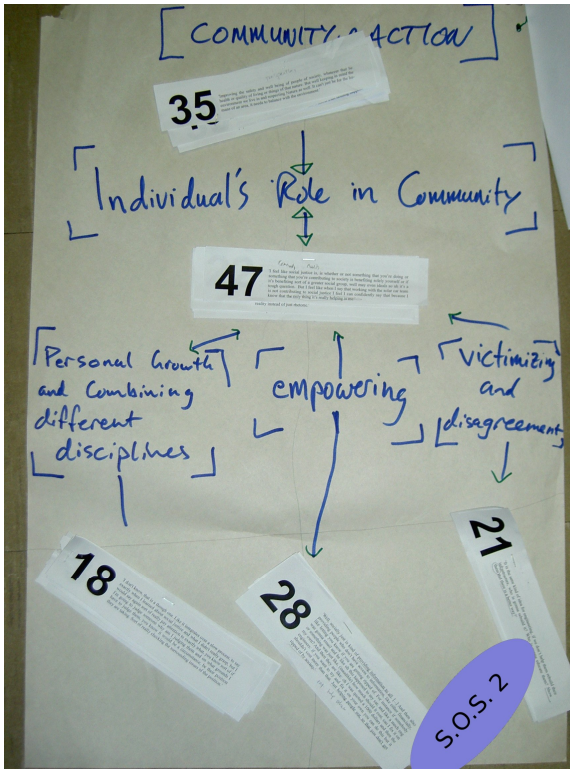
In addition to reading the quotes, the students were asked in very general terms to construct an outcome space by grouping quotes as they saw fit and point out any relations between the groupings. Examples of this can be seen in Figures 2 and 3. In retrospect we should have given the students more instructions of what we expected them to do since there was a degree of confusion present in the class during the exercise which is reflected in this student feedback:

> Student A: *I found it really interesting to read what other students had written. I really wondered about the surrounding context of the short paragraphs we read, and how the paragraphs were selected.*

However, the following student feedback suggests that the exercise achieved its aim:

> Student B*: I really enjoyed the quote exercise. I could see a lot of myself in some of the quotes, and at the same time a lot of views that I definitely do not share. One thing I found is that they helped to clarify some of my views on social justice as I had the opportunity to evaluate whether or not I agreed with the statements being made.*

Figure 3. Another example of a student outcome space



The "jazz style" of teaching

The course was taught in what Day refers to as the "jazz" style of teaching (a fixed structure but which allows creativity to emerge and bloom) which provided the flexibility to adapt aspects of the course to meet the need of the students. One example of this is how the instructors decided in the 2009 class to change the focus of the students' second essay. Rather than writing a critical response to one of the weeks' readings the engineers and the social scientists got different assignments. The engineers were asked to do their best at deconstructing some of their own writing or thinking. The social scientists were asked to find viable alternative solutions to current practices while accepting the constraints of engineering and not simply deconstruct and point out flaws and shortcomings as they might be used to do. We could observe much anxiety in the classroom about this new assignment, but after more detailed instructions with illustrative examples were sent out the students produced some remarkable essays.

Concluding reflections

The course is in its third year and there is a large waiting list of students who want to take it. It gets excellent student feedback and, despite requiring much work and being very challenging for the students is very popular. Continual improvements are being made, particularly in the way in which students are made aware of different ways of thinking. However, it does seem that the particular constellation of a seminar style classroom; two instructors with open minded attitudes willing to critique themselves and each other; a small class size; active community based group projects; interdisciplinary students; a continuing emphasis on critical thinking; and as Day puts it, the "jazz" style of teaching does seem to help students pass through the liminal space and approach engineering through a lens of social justice. This is reflected in these student quotes:

> *SR9 [ENG]: This course has opened my eyes in making me see that there are many different views in the world and that there are no universal solutions or methods when dealing with a problem.*

> *SR10 [DEV]: The structure of the class has been an example of "what could be!" I believe this course is the best and most important course I will take at this strange institution and probably the most influential. Every time I left class I felt like I my brain had really expanded and I was really learning. This process continues outside of class and my passion continues to grow. I have been greatly inspired by the both of you [instructors] and my learning in this class, thank you very much for this.*

Acknowledgements

Thanks to SSHRC for the financial support of the study, to the students enrolled in "Engineering and Social Justice" 2008 and 2009, and Martin French, the course professor during 2008.

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