



**Educating for a socially just
world: A case of engineering
education**

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- ‘Good education may leave students deeply dissatisfied, at least for a while. I do not mean the dissatisfaction that comes from teachers who are inaudible, incoherent or incompetent. But students who have been well served by good teachers may walk away angry – angry that their prejudices have been challenged and their sense of self shaken. This sort of dissatisfaction may be a sign that real education has taken place.’ (Palmer, 1998)

Introduction

- Engineers in a changing world
- Theoretical framework
- A first year course 'Professional skills'
- Humanitarian engineering placements
- Engineering and social justice

What is engineering?

- *“We’re engineers. Engineers solve problems.”*

(MIT’s Provost Robert Brown in Williams, 2002, p. 29)



Engineering is not in a vacuum

Engineers in a changing world

- Globalisation/ global citizenship
 - Interlinked challenges of poverty and environmental sustainability - moral and civic values
 - Disciplinary boundaries get blurred (no more 'thinking like an engineer')
- > Engineers face increasingly complex problems and workplaces**

The codes (George Catalano)

| CODE OF CONDUCT | RELEVANT CANONS AND PRINCIPLES | ATTITUDES TOWARDS SECURITY | ATTITUDES TOWARDS POVERTY | ATTITUDES TOWARDS NATURE |
|-----------------|--|----------------------------|---------------------------|--|
| NSPE | Hold paramount the safety, health, and welfare of the public. | No explicit reference | No explicit reference | No explicit reference |
| ASME | Uphold and advance the integrity, honor, and dignity by using their knowledge and skill for the enhancement of human welfare. | No explicit reference | No explicit reference | No explicit reference |
| ASCE | Hold paramount the safety, health and welfare of the public and shall strive to comply with the principles of sustainable development | No explicit reference | No explicit reference | Sustainable development linked solely to meeting human needs |
| IEEE | Accept responsibility in decisions consistent with the safety, health and welfare of the public, and to disclose promptly factors that might endanger the public or the environment. | No explicit reference | No explicit reference | Endangering environment not explored |
| IIE (ABET) | Shall hold paramount the safety, health and welfare of the public in the performance of their professional duties | No explicit reference | No explicit reference | No explicit reference |
| AIChE | Hold paramount the safety, health and welfare of the public and protect the environment | No explicit reference | No explicit reference | Protecting the environment not explored |

Engineering projects should...

- promote justice
- restore reciprocity (Franklin worries for example that communications technology has become non communications technology – we are decreasing ways of feeding back)
- confer divisible or indivisible benefits (working on ways to improve the environment is an indivisible benefit – everyone benefits)
- favour people over machines
- minimize or maximize disaster
- promote conservation over waste
- favour reversible over irreversible

Martin/Schinzinger

Engineering ethics - informed consent



- Social experimentation based on 'free and informed consent'
- For those who have been socialized into accepting hand-outs as their traditional means of living ..., a non-coerced, non-manipulative, and non-deceptive 'agreement' may not even be strictly possible.

Riley - macro versus micro

- Macro versus micro
- Critical thinking *in* versus *about* engineering
- Consientization - acting through choice



Phenomenography

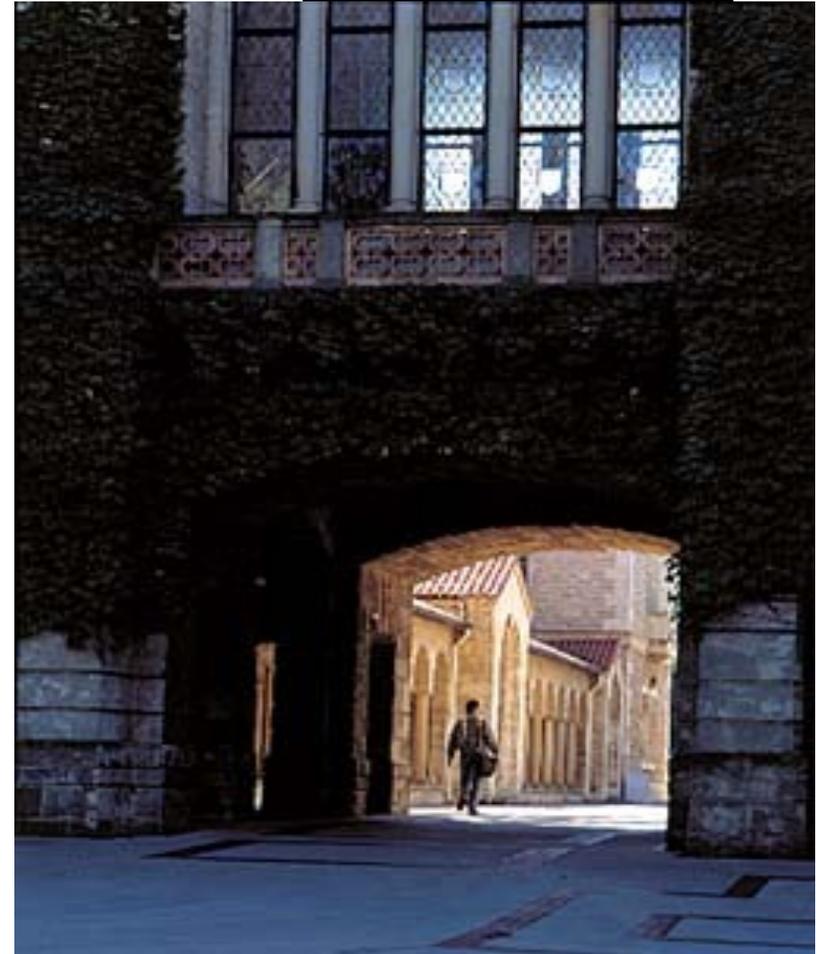
- Non-dualist
- Ways of experiencing something
- Nature of awareness
- Categories of description
- Collective level over individual level
- Focus on variation

Variation Theory

- Discernment, awareness, simultaneity and variation
- Focus pedagogy around variation in and around phenomena's critical aspects

Threshold concepts

- “A threshold concept can be
- considered as akin to a portal,
- opening up a new and previously
- inaccessible way of thinking about
- something.”
- “It represents a transformed way
- of under-standing, or interpreting,
- or viewing something without which
- the learner cannot progress.”



Threshold concepts

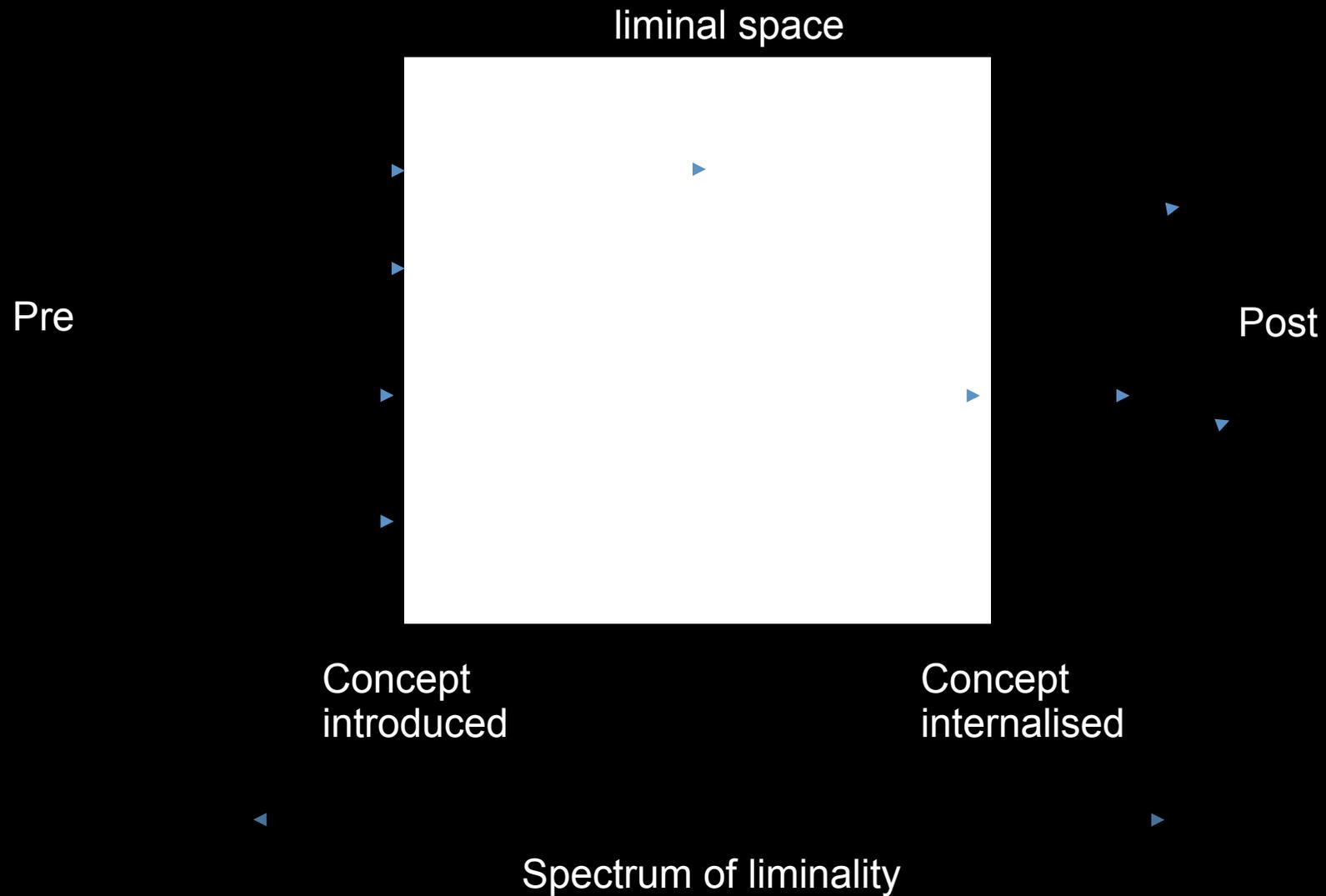
- "This transformation may be sudden or it may be protracted over a considerable period of time, with the transition to understanding proving troublesome."
- "Such a transformed view or landscape may represent how people 'think' in a particular discipline, or how they perceive, apprehend, or experience particular phenomena within that discipline (or more generally)." (Meyer and Land, 2003)

Threshold concepts

Five characteristics:

- Transformative
- Troublesome
- Integrative
- Irreversible
- Bounded

Liminality and variation



Professional skills



Aims

- To provide students with a base on which to develop their approaches to learning
- To provide students the opportunity to think about what it means to be an engineer
- To aid the students in developing response - ability both personally and professionally

Course structure

- 600 students
- 15 multidisciplinary TAs
- Groups of 20
- Teams of 5
- 5 course leaders
- 1 course coordinator
- One intensive week followed by term long self study project in teams

Data collection

- Student questionnaires (320)
- Interviews with a sample of all actors directly and indirectly related (7 students, 7 TAs, 8 faculty)
- Reflection
- Scrutinizing of course material
- Observation of classes
- Assessment of course work 640 students
- Video recording of interactive session
- Feedback collected as part of an interactive plenary with all 640 students
- Student designed course evaluation scheme
- Online evaluation - student run (101)

Threshold areas

Ritual knowledge

'I found that the skills that we are to learn in this programme have been gone over in high school therefore this is more of a repeat course'

Inert knowledge



- 'I felt that this course could have had greater on me personally and potentially on the group if we had looked at more controversial issues instead of the Kingston transport plan'

Conceptually difficult

- ‘in the first week we were taught the Quebec bridge was a disaster because there were three people in charge with no central responsibility. Then you split us into three groups and expect the project to run smoothly. The basic foundation of the project is in complete contradiction or the project we learned in the first week’

Alien knowledge



- 'I have yet to meet an engineer who writes journals'

Tacit knowledge

- ‘When students ask questions of the course administrators it would be helpful if their answers were even moderately clearer than those given during the Clinton Inquiry i.e. that depends what your definition of *is is*’

Troublesome language



- 'The manual uses some fancy buzzwords but they mean nothing and the only purpose they serve is to further confuse the students who are trying to find out what the hell is going on'

Ways of thinking and practising

- ‘I don’t care what people think about ethics. I want a hard concrete right or wrong answer/explanation, otherwise the exercises and cases were useless. I gain/come away with learning nothing at all.’

Summary

- 'Professional skills' appears to be a threshold for first year engineering students
- Many forms of troublesome knowledge are present

Vandersteen/Baillie



- Humanitarian Engineering Placements: Who benefits and who pays?
- Phenomenographic study with 32 engineers and non engineers in Ghana and Canada

Placement is inherently good



‘Engineers can help bring more modern technology.’

Africa requires this.

Africa needs technology for development.’

Placement requires careful training



‘The placement can be good, but we have to make sure the students are properly prepared’

Placement can work with the right attitude and dialogue



‘We should go with an open minded approach. We should first ask, ‘What can we do for you?’ We shouldn’t say, ‘This is what you need. I have your solution.’

The placement is most valuable for student learning

‘The real benefit is when the student comes back..It comes down to their experience and their ability to allow others to feel the same thing that they felt, while overseas. That’s where the value is.’

The learning experience comes
at a great cost and the right
decision might not involve a
placement

‘This is a very big debate, but it reinforces the idea of neo-colonialism. This dependency on outside sources, this destruction of local self sufficiency by the presence of outsiders who are there to help, but most often do nothing. Most often the projects fail. Beyond that we have the impact of arriving, back to our comfortable lives.’

Placement must incorporate social justice

‘Do we have the luxury of doing nothing after all of the damage done by outsiders? Indigenous knowledge has been lost... Ideally, our focus should be on social justice’

Summary

- 1) Social structures are difficult to understand.
- 2) The creation of dependency can be very damaging.
- 3) Placements can undermine others' ability to care for themselves or to demand good governance for themselves.

- 4) Adjusting cultural practices via external influence may not be in the best interest of the community.
- 5) Technology transfer is extremely difficult.
- 6) Outsiders create unequal power relationships.

Marullo/Edwards

- Social justice versus charity



Thought Collectives

- For something to be known, it must fit within the relevant community's paradigm or thought collective' (Baillie, Rose)
- Thought collectives 'constrain the individual by determining what can be thought in no other way'(Fleck)

When two thought styles collide

- ‘The alien way of thought seems like mysticism. The questions it rejects will often be regarded as the most important ones, its problems as often unimportant or meaningless trivialities’ (Fleck)

Community of practice

- Through engagement, competence can become so transparent, logically ingrained and socially efficacious that it becomes insular..In this way a community of practice can become an obstacle to learning by entrapping us in its very power to sustain our identity' (Wenger)

The issue at hand



- How can students be encouraged to adopt a social justice lens toward their practice and profession?

Hypothesis

- It is hypothesised that for engineers, both practicing and students, adopting a socially just perspective to their practice and profession can be seen as a *threshold* that needs to be crossed and that this transition might prove both transformative and troublesome.

Course: Engineering and Social Justice

Engineering and Sociology

Seminar style

Weekly readings

Different perspectives on social justice

Classroom discussion

A project focused on a SJ issue

Method

- Capture the students' perspective
 - Interviews
- Multiple forms of data
 - Focus groups
 - Observation
 - Student assignments
- Data collected continuously
- Maximise variation
- Triangulation
- Create a robust outcome through iterative analysis



No understanding

Random
characteristics
and fragmented
understanding

Charity

Duty and
responsibility

'Trustee care'

Taking action
for change

Being
response-able

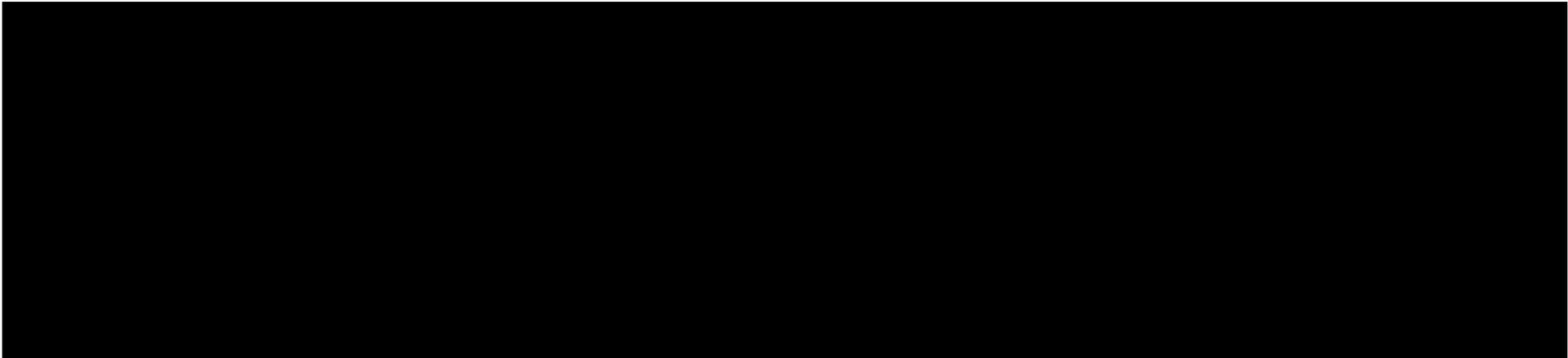
A participatory
undertaking

Lens for
deconstruction
and critical
analysis

PRE

POST

Spectrum of liminality



Pre-liminal

- S11: 'I'm really glad I don't live in Argentina and I really think anybody in their right mind would want to live in a society where even if you weren't per se seeing the profits, you would want to live in a society where someone was.. I would be surprised if anyone is happy with the situation in Argentina.'



Social justice as random characteristics and fragmented understanding

- S2: ‘feeding people like foreign aid and stuff like that,we’re like helping people who need to be helped’

Social justice as charity



- S5: ‘It is the same kind of idea for engineering, if we don’t help them rebuild their infrastructure, who is gonna rebuild it? Who is gonna educate them? Show them that there is a better way?’

Social justice as duty and responsibility

- S5: 'It all comes down to doing what is right. Do you think it's right? Like, if you saw, you know, someone weak being bullied by someone in the street, would you do something about it? Well, you should. Morally you should do something about it. It is having the moral courage to act.'

Social justice as telling people what to do or 'trustee' care

- S5: 'Instead of us going in and building it for them [...] it's like a mentorship program, apprenticeship as well. We take people from [local university] and teach them how to do it. [...] So we don't do it, we get them to do it and we pay a local elder to pay workers to do it. We show them how to do it. [...] trying to educate them not just doing it for them. [...]

Social justice as taking action for change

- S12: ‘So you take a choice, you decide to get involved and once you make a choice even then you still have to take action. It doesn’t matter, I could make the choice to go help someone, but until I actually do it I haven’t really done much, right?’

Social justice as being response-able

- S7: ‘my concept is this is what I need to stop doing, this is what I need to stop other people from doing and this is like, this is the system I need to understand and understand how to change and I understand less about what to do as an alternative you know like how to, I just know that what is happening is unjust.’

Social justice as participatory undertaking



S8: 'You realize that social justice can't come from one and it has to, it's a dynamic process where you have to communicate with people. [...] collaborating with different people and their ideas to synthesize all these ideas and to make sure that you know whatever practice you're doing everyone benefits.'

Social justice as a lens for deconstruction and critical analysis

- S9: ‘You should try and see what actually caused this to happen, cause if it burst once it can burst again and the same thing with social justice and charity is that if you just kind of perform charity acts, yeah you might have helped one person in one situation, but who’s to say the underlying factor won’t cause the exact same thing to somebody else. So social justice, social change is trying to figure out well what’s the fundamental problem or what’s the root cause of what you’re seeing.’

Student perceived barriers

- Common sense views of engineering

‘[in class] everyone kept bringing up efficiency. [...] and I just thought why is efficiency so important and my personal kind of conclusion was that it’s because we have to make a profit...I feel like that concept being so prevalent is why the environmental crisis seems inevitable to me is..this idea of growth just doesn’t seem to get questioned. [...] I mean I know people who are very environmentally conscious and they do their best and they’re .. very positively favoured towards environmental causes, but the idea of not growing still seems just so hard to imagine to them and I think those two things conflict’



Personal challenges and risks

- S13: ‘[The course] really messed with my head. Sometimes I was scared going to class because I didn’t want to think about stuff. [...] it put some guilt on my actions [...] I feel that it might have an impact on my success in a company, for example if I don’t do it the next person might.’

Levine/Baillie

- Current ethical codes in engineering rely on some noncontroversial, non-specific and hence non-existent notions of diversity which result in giving engineers virtually no ethical direction whatsoever.
- Real participatory design will change what gets designed, created and developed from the point of nucleation.
- Rethinking what engineering is and what it involves (not thinking like an engineer)

Implications....



- Implications for engineering education
- Implications for engineering
- Implications for other professions
- Implications for education/education research in general

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