

Raising Critical Consciousness in Engineering Education:
A Critical Exploration of Transformative Possibilities in
Engineering Education and Research

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Abstract

This thesis represents a critical exploration of the opportunities, challenges, and barriers to enacting social justice via the engineering curriculum. Through an ethnographic case study of a British engineering for sustainable development course, I illuminate tensions and contradictions of attempts to “do good” while “doing engineering” in a higher education setting. This work is couched within critical and anti-colonial theoretical frames. Through critical and reflexive analysis, I illustrate attempts of participants to innovate in engineering education toward a counter-hegemonic engineering practice, and highlight transformative possibilities, as well as barriers. This case illustrates how the structures that formed modern engineering continue to shape engineering higher education, restraining attempts to transform engineering training for social good.

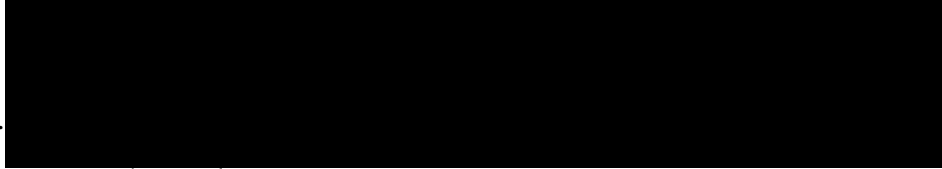
A central question that has driven this work has been: *Is it possible to cultivate a more socially just form of engineering practice through engineering higher education?* The function of asking this question has been to interrogate a core assumption in engineering education research – that with the right blend of educational interventions, we can make strides towards social justice. My intent in interrogating this assumption is not to be nihilistic per se. I believe it is entirely possible that engineering *could potentially* be wielded for just cause and consequence. However, if we do not critically examine our core assumptions around this issue, we may also miss out on the possibility that socially just engineering is *not* achievable, at least in the way we are currently approaching it or in the current context within which it exists.

An examination of this topic is already underway in the US context. However, it is under-explored in a British context. Given the different historical trajectories of engineering and engineering in higher education between these two contexts, a closer look at the British context is warranted.

Declarations

This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

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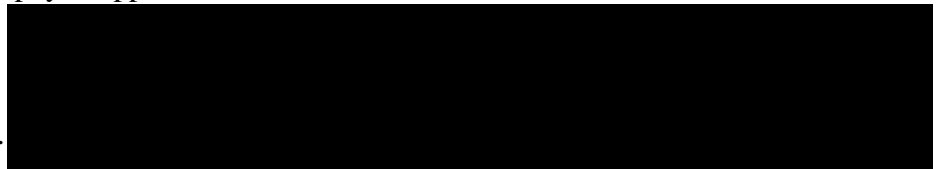


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This thesis is the result of my own investigations, except where otherwise stated. Other sources are acknowledged by footnotes giving explicit references. A bibliography is appended.

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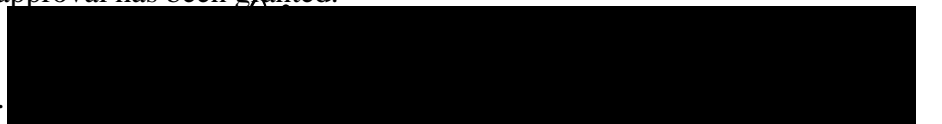


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The University's ethical procedures have been followed and, where appropriate, that ethical approval has been granted.

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Publications

Chapter 7 is based on work previously published as Orbaek White, G., Xavier, P., & Groves, C. (2020, June 22). The Places They Will Go: What Happens When Engineering Students Critically Reflect. 2020 ASEE Virtual Annual Conference.

Acronyms and Abbreviations

ABET	Accreditation Board for Engineering and Technology
AHEP	Accreditation of Higher Education Programmes
BP	British Petroleum
CCF	Community Cooker Foundation
CoE	College of Engineering
EC	Engineering Council
EDI	Equity, Diversity & Inclusion
EER	Engineering Education Research
ELM	Engineering Leadership and Management
GCRF	Global Challenges Research Fund
GDP	Gross Domestic Product
HEI	Higher Education Institution
HoC	Head of College
ICE	Institution of Civil Engineers
IEE	Institution of Electrical Engineers
IMechE	Institution of Mechanical Engineers
ISL	International Service Learning
MOU	Memorandum of Understanding
MSc	Master of Science
PoW	Prince of Wales
PBL	Problem-Based Learning
SEM4ID	Sustainable Engineering Management for International Development
SEN	Special Educational Needs
SNG	Siavonga Nutrition Group
SU	Swansea University
UBC	University of British Columbia
UK	United Kingdom
VSO	Voluntary Service Overseas

Introduction

The engineering status quo

Engineers have been responsible for the development of some of the most consequential and widespread technological innovations in human history (Amadei, 2014; Downey, 2014). From water sanitation systems to refrigeration to mobile phones to trains and cars and airplanes, the vast impacts of engineers on the world in which we live are undeniable. As we as a society are faced with unparalleled challenges, from the climate emergency to rising inequality to Western political destabilization, there is a renewed emphasis on the role of engineering professionals to contribute solutions to global problems.

In the United Kingdom (UK), engineering is valorised as an engine of progress and economic vitality. It is a field looked to support technological innovation, which will support society in addressing the multiple, complex human struggles of our time. The British government inscribed its reliance on the engineering sector through its 2017 Industrial Strategy. In articulating four “Grand Challenges” within this strategy – putting “the UK at the forefront of the artificial intelligence and data revolution”; becoming a “world leader in shaping the future of mobility;” maximizing advantages for UK industry to shift to clean growth; and harnessing “the power of innovation to help meet the needs of an ageing society” – the government centred technological advancement and a strong engineering workforce at the heart of its economic agenda (HM Government, 2017, p. 14).

It is no wonder that engineering is central to British economic policy; engineering enterprises generated 23.2% of the UK economy’s £5.3 trillion turnover. They were 56% more productive (Gross Value Added/person) than the retail and wholesale sector and employed almost 20% of the UK labour force. By 2020, the contribution was projected to increase to £608 billion (Neave & Wood, 2018). Given the precarious political and economic context that the UK finds itself in, in large part due to Brexit, the ongoing COVID-19 pandemic, and the current crisis in Ukraine, the contribution of the engineering sector to the national bottom line has taken on increased relevance.

While the engineering profession is generally viewed as trustworthy, it is crucial to recognize that engineering innovations and interventions have not necessarily always led to positive or beneficial change for all (Clemence, 2020). High profile engineering disasters - from the Bhopal disaster to the Grenfell tower fire – are some of the more obvious indicators of a disconnectedness between engineering and society. These cases speak to a variety of failures within engineering design (Vallero & Letcher, 2012), and/or lax or socially irresponsible institutional cultures. But they also speak to the way that economic structures shape engineering industry, by exerting the power of monetary efficiency as a top priority over human lives. These and other cases have been linked to prioritization of the bottom line/profit over safety and security of the public (Amadei, 2014).

For instance, the Boeing 737 Max disasters, involving 2 crashes and 346 lives lost, “exposed fraudulent and deceptive conduct by employees of one of the world’s leading commercial airplane manufacturers” (Department of Justice, Office of Public Affairs, 2021, para. 3). At the conclusion of a successful lawsuit, resulting in compensation for the families of victims of the crashes, then Acting Assistant Attorney General David P. Burns of the US Justice Department’s Criminal Division remarked: “Boeing’s employees chose the path of profit over candor by concealing material information from the FAA concerning the operation of its 737 Max airplane and engaging in an effort to cover up their deception” (Department of Justice, Office of Public Affairs, 2021, para. 3).

Another recent disaster was the fire at Grenfell Tower. In 2017, a fire broke out in an apartment in the high-rise London tower block. The fire led to the deaths of 72 people, “the greatest loss of life from a fire in Britain since World War II” (Tsavdaridis, 2018, para. 1). The extent of the disaster was, in part, associated with new cladding applied to the building that was added onto the building in 2016, which though it followed some building regulations, was not fit for purpose and led to the catastrophic outcome. The issue with the cladding was related to its failure to compartmentalise the fire. In fire engineering, the concept of compartmentalisation is widely applied in the construction of buildings and dwellings. Compartmentalisation involves the use of fire barriers, such as doors and windows, which allow time for occupants to evacuate in case of fire. This was not the case in the Grenfell Tower.

Instead, the fire travelled up the outside of the building, resulting in what was considered a “chimney effect.” This disaster led to an independent investigation into Building Regulations and Fire Safety, led by Dame Judith Hackitt. The inquiry found that the industry, responsible for designing, developing, and installing the cladding, were in part, responsible for the disaster. In designing and selling cladding that had the potential for this chimney effect, industrial stakeholders demonstrated a disregard for the potential consequences of their designs. During an Institute of Civil Engineers Strategy Session, Dame Hackitt charged industry with a lack of responsibility and accountability in preventing this disaster. “What shocked was the extent to which industry knew that something was wrong, but were not motivated to do something about it themselves...They saw it as somebody else’s problem” (Kirkup, 2020, para. 3).

These high-profile examples may increase the public salience of the precarity of engineering products and structures, but it is the less obvious examples that shed light on the more insidious and subverted nature of engineers’ lack of connectedness to broader social accountability. Consider the role of engineers in developing technology for military and war applications. Approximately 33% of the engineering workforce in the US is employed in “military related activities” (Bowen, 2009, p. 7). Peaceful applications of engineering also have unforeseen impacts. Bugliarello (1991) offers the following provocation:

Would the societal consequences have been different if engineers had been more involved in a systematic study of engineering's complex role in society, had a working dialogue with social scientists, and had better communication with the public? For instance, could we have anticipated that the automobile would turn out to be a severe source of pollution as well as a powerful instrument of urban change, that radios in every household would catalyse the political emancipation of women, or that television would influence our values and contribute to functional illiteracy? (p 74).

More recently, could engineers who developed and helped deploy the algorithms for individual data harvesting have known that they might be used to target voters and manipulate elections? Answering these questions requires nuanced, multi-level political, ethical, and social conversations which involve engineers. However, “the

voice of engineers in the discussion of engineering's social role has been weak, episodic, and often self-centred" (Bugliarello, 1991, p. 73).

When they do examine issues of professional responsibility, engineers tend to focus on micro-ethics, rather than macro-ethics. Micro-ethics focuses on the relationships "between individual engineers and their clients, colleagues and employers," whereas macro-ethics involves the examination of the "collective social responsibility of the profession" (Herkert, 2005, p. 374). A micro-ethical perspective is ineffective in a globalized industry that largely regulates itself. Individual ethics make little impact on institutional decisions, particularly in large corporate settings, where engineers "tend to be absorbed in management hierarchies and values and tend to use business considerations as appropriate criteria for engineering decision-making" (Conlon, 2008, p. 153). A micro-ethical perspective is even more limited in a sector where "externalities" or the true costs of innovations and advances are "not generally recognized or factored into societal forecasting, planning and accounting" (Amadei, 2014, p. 103).

Engineering cultural formation

As the previous examples demonstrate, the ways in which engineers view themselves in relation to the wider world, and the ways in which they act and apply their engineering knowledge are not neutral or consequence free. So how is it we have a profession like engineering that is so vital to us as a society, yet consistently misunderstands and eschews crucial aspects of its social responsibility? Here, I explore this issue through the lenses of culture, ideology, and epistemology. I then introduce the concept of episteme as a potential framework for considering engineering formation through a historical lens.

Cech attributes the disconnect between engineers and society to the *culture* of engineering and certain ideologies held within that culture (Cech, 2013). Cech defines the professional culture of engineering, like other professional cultures, as one with distinct "sets of beliefs, myths, and rituals that give meaning to the intellectual content and practices of a profession." This professional culture is underpinned by "particular ideologies" which "serve as orienting frameworks for how engineers understand both the relationship of their profession to society and

their own roles as individual professionals.” Such ideologies inform what generally counts as ‘legitimate’ engineering work. They “not only shape how individual engineers think about and enact their day to day professional work, but also the decisions profession leaders make about the direction of engineering in the future” (Cech & Sherick, 2015, p. 205).

Cech theorizes that engineering culture is *disengaged*, or a culture in which concerns about public welfare and social justice are separate from engineering work. This culture, she argues, is reinforced through the ideologies of *depoliticization* and *meritocracy*, alongside a technical/social dualism (Cech, 2014). The ideology of depoliticization is “the belief that engineering is a purely ‘technical’ space in which engineers design technological objects and systems” (Cech & Sherick, 2015, p. 205). An ideology of meritocracy perpetuates the notion that social systems are fair, and any inequality found within them is the result of individual failings. The technical/social dualism involves the artificial separation of technical and social forms of knowledge. Bowen, a prominent engineering ethicist echoes Cech’s notion of the technical/social divide, asserting that there are “significant imbalances in the application of engineering knowledge” which “reflect a tendency for engineering, as presently taught and practiced, to prioritise technical ingenuity over helping people” (Bowen, 2009, p. 6). These ideologies reinforce one another to perpetuate a disengaged culture, where social considerations are well outside of the realm of technical engineering problem solving.

Amadei furthers the notion of the technical/social dualism, drawing from Schön in suggesting that the epistemology of engineering practice is rooted within *technical rationality*. Schön (1983) originally defined technical rationality as an adherence to the view that problem solving is only rigorous when scientific theory and technique is applied. He argued that major professional bodies, including engineering, “are grounded in systematic, fundamental knowledge, of which scientific knowledge is the prototype” (Schön, 1983, p. 23). Schön asserts that technical rationality is not only a guiding framework for professional knowledge but is a model “embedded in the institutional context of professional life. It is implicit in the institutionalized relations of research and practice, and in the normative curricula of professional education” (Schön, 1983, p. 26). Taken together, we can understand

technical rationality as a belief system that creates boundaries around *ways of knowing* in engineering. Technical rationality shapes how engineering institutions prioritise and incentivise particular ways of “doing engineering” and creates boundaries around how problems are framed and solved in engineering research and practice.

How did this culture form? Where did these ideologies come from?

“Engineering, like other professions, is not just a collection of knowledge, skills, and practices grouped into a set of jobs. Professions have rich and historically rooted cultures that are built into and around their knowledge, skills, and practices” (Cech, 2013, p. 3). Lucena, tracing the evolution of engineer’s involvement in national and international development, asserts:

“...until we fully understand the history of how engineers came to be involved with development and communities and the consequences of this history for present-day practices and projects, and appreciate the influence of the engineering mindsets on how engineers define and solve problems, it will be very difficult for engineers to achieve effective, sustainable and socially just community development” (J. Lucena, 2015, p. 226).

The following exploration delves more deeply into the historical foundations of modern-day engineering in the UK.

To link the formation of engineering culture with its historicity, I draw from Foucault’s concept of episteme. In his work, *The Order of Things*, Foucault develops an analytical technique called “archaeology.” Foucault’s archaeology involves a process of excavating the basis of knowledge at different time periods and showing how knowledge has evolved and changed over time as new ideas came into being. Critical to understanding how we can know anything, is to trace the boundaries of our knowledge through historical context. In so doing Foucault argues it is possible to “bring to light” an “epistemological field” or an “episteme;” through tracing the way that knowledge exists and changes over time, we can better understand the “conditions of [its] possibility” (Foucault, 1970, p. xxiv). According to Foucault, an episteme “delimits in the totality of experience a field of knowledge, defines the mode of being of the objects that appear in that field, provides man's everyday perception with theoretical powers, and defines the conditions in which he can sustain a discourse about things that is recognized to be true” (Foucault, 1970, p.

172). Bevir, a scholar of Foucault, suggests that “an episteme is a fundamental code governing the way in which people understand, and act in, the world. Although epistemes are rarely held consciously, they exercise an all-pervasive influence, saturating all of the religious, philosophical, scientific, social, and artistic thought and practice of an age” (Bevir, 1999, p. 347). Said in another way, an episteme is a culturally and historically constructed boundary condition that frames knowledge and understanding of the world. In his later work, Foucault incorporates the concept of power in his analysis of knowledge, through “genealogy.” Genealogical analysis aims, in part, to uncover the way that power relations form and are perpetuated through history by illuminating their role in serving specific social agendas (Foucault, 1980).

If we are to acknowledge that the formation of engineering culture occurred through a historical trajectory, then it is important to spend some time understanding critical moments in the formation of modern engineering culture. Where did the technical/social divide evolve from? Was engineering always like this, or was it something else at some point? Downey and Lucena suggest that “the identity of the engineer” emerged during the Enlightenment period (Downey & Lucena, 2005, p. 4). The *episteme* of the British engineer, therefore, must be understood through the lens of this historical period.

In the United Kingdom, the Enlightenment period intersects with British imperialism and colonisation. In fact, Enlightenment ideals of progress, and specifically technical rationality, or progress through science and technology, were fuel for empire building.

This particular notion of progress was undergirded by positivism, a philosophic position which emerged during the Enlightenment era in Europe, as a move to “cleanse men’s minds of mysticism, superstition, and other forms of pseudo-knowledge” (Schön, 1983, p. 32). Positivism rests on the assumption that there is an objective truth, and it is possible to uncover that truth through the theory and methods of science (Denzin & Lincoln, 2008). “By the late nineteenth century, Positivism had become a dominant philosophy...The only significant statements about the world were those based on empirical observation, and all disagreements about the world could be resolved, in principle, by reference to observable facts.

Propositions which were neither analytically nor empirically testable were held to have no meaning at all. They were dismissed as emotive utterance, poetry, or mere nonsense” (Schön, 1983, p. 33).

British imperialism demanded a pragmatic technical rationality, with value placed heavily on technical knowledge, quantitative data, and positivistic ways of knowing. Engineers were central to social and political goals of the age. A brief history of this context is provided in the following sections.

Engineering and capitalist colonial expansion

Throughout the 18th and 19th centuries, a new form of imperialism was on the rise, in the form of Western capitalist colonial expansion. Colonisation is defined by Loomba (2002) as the “conquest and control of other people’s land and goods.” The process of colonisation has meant “unforming or re-forming” existing communities by colonizers, using a wide range of practices, including “trade, plunder, negotiation, warfare, genocide, enslavement and rebellions” (Loomba, 2002, p. 2).

European empires were not the first to expand imperial might or establish colonies abroad. But the form of imperial expansion advanced by European powers, including the United Kingdom, was distinct. “Never before had one civilization overwhelmed all the others and set them on an entirely new course” (Headrick, 1988, p. 4). “Modern colonialism did more than extract tribute, goods and wealth from the countries that it conquered - it re-structured the economies of the latter, drawing them into a complex relationship with their own, so that there was a flow of human and natural resources between colonised and colonial countries” (Loomba, 2002, p. 3). One aspect of “re-structuring” new colonies involved transforming non-capitalist economies into those that could be exploited by European capitalistic interests. “This allows us to understand modern European colonialism not as some transhistorical impulse to conquer but as an integral part of capitalist development” (Loomba, 2002, p. 20).

The “physical and material dimensions” of this new form of imperial expansion were advanced through the vehicle of engineering and technological innovation. Engineers were heavily involved in the construction of colonial infrastructure that facilitated extraction (J. Lucena, 2015). Technological innovation

and invention, such as steamships, and improvements in firearms and railways, increased the speed and efficiency, and decreased the cost, of colonial expansion into African and Asian territories. Technology was developed by Western engineers and scientists, for the benefit of the West, and “with scant regard for their long-range impact on the tropics.” (Headrick, 1988, p. 7).

It was through their labour that engineers served the interests of imperial governments in building out their empires. By helping to permanently transform the structure of life in colonies throughout this time, engineers, whether consciously or not, participated and became complicit in the rise of capitalist colonialism (Loomba, 2002; J. Lucena et al., 2010; J. Lucena & Schneider, 2008).

This relationship is not over. It has been argued that the historic alignment between engineering, colonisation and capitalistic interests has not radically changed since the colonial age (Conlon, 2019; J. Lucena et al., 2010; Slaton, 2015). Some attest that that the colonial era never really ended, it just evolved into new forms of extraction and dehumanization, with engineers continuing to play a pivotal role in these systems (Boisselle, 2016; Dei & Kempf, 2006; Smith, 1999).

In considering how the relations between engineering and colonisation persist into the present day, Maureen McNeil, speaking of the vast human toll of the 2006 tsunami that hit southeast Asia, asks the question: “why are communication systems in India so effective in servicing Western consumers through call centres but incapable of providing crucial environmental warnings to those living in that country?” (McNeil, 2005, p. 105). Considering this question evokes the impression of the continued extraction of human resource from a former British colony for the convenience of the West, at the expense of self-development and security.

The case of sea defence infrastructure in Guyana is another example that illustrates how the colonial regime gained a foothold and became entrenched, the effects of which persist today. Mullenite (2018, 2019) critically examined the social and political ramifications of colonial and postcolonial flood remediation projects in Guyana through genealogical analysis. During the colonial era, British colonialists infiltrated and gained increasing control over daily life through the construction and management of sea defence infrastructure. This strategy was extended by the

postcolonial Guyanese regime, using “infrastructural commitments to maintain and grow their economic and political power” (Mullenite, 2018, p. 187). Though the British regime formally ended in 1966, it is only recently that the Guyanese have begun reviving nature-based, indigenous sea defence solutions, such as regrowth of mangrove forests (p. 175). This work highlights how a technological approach to flood management embedded a capitalist, colonial politic, an approach that has persisted into the present day.

The status quo reinforced through engineering education

Through this historic lens, we can better understand the contextual factors that have shaped the episteme of engineering practice. In the following sections, I zoom in on the institutions that have reinforced the engineering episteme. According to Cech, “the most concentrated presentation of professional culture is through professional socialization – the training process by which students move from being neophytes to professionals” (Cech, 2013, pp. 3-4). In engineering, this occurs through a variety of mechanisms, including on-the-job training, apprenticeship, and through higher education. The following inquiry will examine engineering higher education as a site out of which the engineering status quo emerges.

In a higher education context, the cultural ideologies of engineering are inscribed, in part, through the curriculum. The “traditional” engineering curriculum in higher education, or what has become the standard curriculum, particularly in North America and Europe, focuses on narrow approaches to problem framing and problem solving, which are decontextualized, technical and rely on instrumental rationality (Buch & Bucciarelli, 2015; Downey, 2015). Bugliarello argues that the engineering curriculum has rarely included sociotechnical problems as an “important sphere of engineering activity” (Bugliarello, 1991, p. 75). Buch and Bucciarelli suggest that “for a problem to be treated as an engineering problem it must be expressed in quantitative terms,” (Buch & Bucciarelli, 2015, p. 498) reinforcing a technical/social dualism.

In the UK in particular, engineering higher education in the 20th century has been characterised as science and maths focused, lecture-based, with supplemental exercises and laboratory experiments involving “‘closed’ experiments (with known

outcomes)” (Goodhew et al., 2017, p. 7). Prior to 2000, the majority of engineering degrees culminated in a year-long research or design project, “often conducted in the department’s research laboratories.” However, though research methods and design feature as taught subjects in the British engineering curriculum, “in most cases the students...neither work in a team, nor make anything” (Goodhew et al., 2017, p. 7).

Calls have been made to embed socially relevant topics, such as ethics, sustainability, and equity, diversity, and inclusion (EDI), into the curriculum. And though progress has been made in doing so, the ways that this has been done have proven instrumental and have not necessarily led to changes in attitudes around engineering graduates’ perceived beliefs about their role in society. As in engineering practice, ethics education within the engineering curriculum frame ethical issues in engineering too narrowly, lack organisational context, and miss the macro-ethical dimensions of engineering practice (Bucciarelli, 2008).

Given the political, economic and cultural context engineers work within, Amadei suggests that engineers “do not have the skills, tools, nor the education to address the global problems that our planet is facing or will be facing within the next 20 years” (Amadei, 2014, p. 101). Buch and Bucciarelli suggest that “discussions about reform in engineering education have mainly centered on issues of curriculum and didactics [or pedagogy] but these discussions rarely address fundamental questions about the nature and character of knowledge and learning” (Buch & Bucciarelli, 2015, p. 497).

The curriculum and pedagogical approaches of engineering higher education are influenced by a complex web of cultural and structural factors. In the United Kingdom, engineering industry and higher education have historically influenced and shaped one another (Divall, 1990). To illustrate this relationship, I briefly outline the historical context and deep entanglements between engineering industry and higher education in the UK.

Institutional mechanisms that have shaped British engineering higher education

Engineering professional institutions, led by the Institution of Civil Engineers (ICE), the Institution of Mechanical Engineers (IMechE), and the Institution of Electrical Engineers (IEE), have held significant responsibility in shaping engineering higher

education in the UK since the 1800s. At the time, the relationship between employers and professional bodies was synergistic. Employers were represented within decision making bodies of the professional institutions by senior engineers. They helped shape entry requirements and standards of practice for the field. Engineering graduates or trainees could not expect a successful career without membership. Membership into professional institutions created a pool of potential labour with verified training and experience for employers to easily find talent.

Through the late nineteenth century, most engineers in England and Wales received hands-on training through “pupillage” or apprenticeship, paying high premiums for entry (up to £500 at the time). For many decades through the nineteenth century, the professional institutions acted as gatekeepers, effectively blocking the proliferation of university-based training for engineers as they benefitted from pupillage premiums (Divall, 1990). This made the training of engineers within university settings a relatively modern phenomenon in the UK, compared to other European nations.

This began to change around the turn of the 20th century, when competition for highly trained members forced the hand of large professional bodies. Engineering graduates, with their advanced theoretical training, were increasingly responsible for important technological innovations, which were more widely recognized as critical for economic growth and maintaining international competitiveness. This, coupled with the formation of new professional institutions that were willing to “recognize the university degree as part of a professional engineer’s training,”(Divall, 1990, p. 70) stepped up pressure on establishment institutions to do the same. By 1913, most engineering professional bodies had established their own formal examinations as an entry requirement, with exemptions granted to graduates of British universities, thus signalling broader recognition of the value of university degrees (Divall, 1990).

Even before engineering professional bodies and employers embraced university degrees as part of engineering training, they played a role in forming the engineering curriculum. This role increased after formal recognition and continues to the present day.

The formation of the engineering curriculum has not been linear; instead, its formation might be represented as a negotiation between engineering professional bodies, employers and academics. One area of tension and flux amongst these parties involved waxing and waning favour for a “high” form of training, involving emphasis on engineering science. Part of this tension resulted in the heterogeneity of professional standards and universities and colleges that attended to those standards. Universities maintained a consistent emphasis on a “high academic” approach, involving more abstract skills in mathematics, and science-based inquiry, and less importance placed on practical skills. Technical and municipal colleges, which were more heavily influenced by local employers, placed higher importance on practical skills of design and management. Universities and colleges aligned themselves with different professional institutions, depending on how their respective curricula aligned with membership entry requirements.

It is important to note that the instantiation of “scientificness” into engineering higher education was reinforced by “wider political [and economic] currents.” This trend was particularly strong in the 1930s, when there was a renewed emphasis in “British positivism, lauding ‘science’ and the ‘scientific method’ as a talisman capable of treating economic and, indeed, other social ills,” (Divall, 1990, p. 95) which at the time were pressing and culminated during World War II.

The relationship between engineering professional institutes, employers and universities has continued to evolve and become more formalized, as professional and higher education standards have been established and successive reforms have been passed. As the profession has grown and differentiated into more specialised technical areas, the number of professional engineering institutions and degree and other training programmes have proliferated. Whereas there were three primary engineering professional institutions around the turn of the 20th century, there are over 50 professional engineering institutions today. In addition, new regulatory institutions have been established to oversee professional standardization.

Modern Context of Engineering Education in the UK

Today, the Engineering Council (EC) is the primary regulatory body for the engineering profession in the UK. The EC is responsible for setting professional

standards of practice, registering engineers and technicians into a national register, and implementing licensure requirements. Their stated goal is to ensure “government and wider society – both in the UK and overseas – can have confidence in the knowledge, experience and commitment of engineers and technicians on the register” (*Engineering Council, 2022, para. 3*).

One mechanism by which the EC ensures the standard of engineering training in the UK is through the Accreditation of Higher Education Programmes (AHEP). Currently on its fourth edition, the goals of AHEP are to:

- “Ensure that UK engineering education provides those industry-relevant skills
- Draw students towards a career in the engineering profession
- Demonstrate, both nationally and internationally, the high standard of UK engineering education
- Provides a basis for HEIs to review their programmes and develop excellence in delivery and content” (*Engineering Council, 2020, p. 6*)

AHEP is both a framework and a process for assuring the standards set by relevant professional institutions are maintained in the curriculum. Engineering Council Licensees accredit individual programmes about once every five years.

Accreditation is considered the gold standard in higher education writ large but is particularly important in engineering education. Though it is not essential for chartership, enrolling in a programme accredited by an engineering professional body creates a straightforward pathway for students to gain chartership. Gaining chartered status is an essential qualification for career advancement in an engineering career.

However, accreditation has been identified as a potential structural barrier to *re-politicizing* the engineering curriculum. In the US,

“...although they have little formal power to shut down non-compliant engineering programs or to facilitate change in the profession beyond engineering education, the formal accreditation processes of the Accreditation Board for Engineering and Technology (ABET, Inc.) carry tremendous *symbolic* significance: for engineering programs to be recognized as legitimate purveyors of engineering training, they must be accredited. Unaccredited engineering programs are disadvantaged in competing for the top students, and students without degrees from accredited programs are

disadvantaged in securing top engineering jobs and professional licensure” (Cech & Sherick, 2015, pp. 208-209).

Though the British engineering education accreditation process goes by a different name (AHEP), accreditation exerts similar power to shape the engineering curriculum in the UK. A recent interview study explored how engineering educators in the UK understand how accreditation helps or hinders the incorporation of social concerns in the curriculum. Findings indicate that accreditation does exert pressure on the construction of the curriculum, however responses varied about the ways in which accreditation shapes the curriculum. To some, it seems to act as a floor – creating a minimum standard by which engineering curricula should be designed. In this way, there is little incentive to innovate beyond the established framework. For others, it appears that accreditation drives change – educational institutions must ensure students meet learning outcomes set within the framework to gain and maintain accreditation (Xavier et al., 2022). If these requirements are not met, universities must drive change, or become at risk of losing their valuable accredited status.

In the UK, there may be new opportunities to incorporate social concerns into the curriculum with the introduction of an updated accreditation framework (AHEP4), implemented in December 2021. This updated framework will provide engineering educators with more latitude to define learning outcomes around a “new emphasis on broadly defined problems and complexity” (Xavier et al., 2022, p. 80). Interviewees in the aforementioned study were optimistic that this new framework would allow more space to integrate a variety of social considerations into the curriculum. However, as described previously, social concerns do not yet have a natural home in in the engineering curriculum. It remains to be seen if accreditation will be enough to overcome the epistemic, cultural, and structural barriers to meaningfully integrate the “social” into the technical.

In parallel to AHEP, the Bologna Declaration (1999) launched a European-wide process of higher education standardisation, which has been influential in shaping the engineering curriculum. The Declaration and ensuing Bologna Process was a European-wide effort to “harmonise” the “structural features of European higher education systems” (Wächter, 2004, p. 265). The overarching goals of this

process were to enhance mobility and employability of graduates, by establishing comparable systems of degrees and degree credits. Though the degree to which the Bologna Process has achieved its aims is contested, the Engineering Council has developed a framework for certain accredited engineering degrees to gain certification as compatible with European professional qualifications (*European Accreditation (EUR-ACE)*, 2022).

Organisation of thesis

We must understand our past before we can envision where we need to go. Therefore, this introduction has laid out the historical and structural factors that have shaped engineering practice and engineering higher education to date, along with the features and limitations of the current state of engineering for social justice in the British higher education context. The remainder of this thesis will:

- 1) Explore existing reform efforts in engineering education toward a more socially responsible and just practice,
- 2) Provide an empirical analysis and critique of one such attempt,
- 3) Offer recommendations on future reform efforts for engineering education for social responsibility and social justice.

Chapter 1 delves into existing approaches and models for engineering education for social justice, as well as the context of the case study.

Chapter 2 provides an in-depth critical reflection on my methodological journey doing critical research in engineering education. It considers methodology in engineering education research and the challenges of advancing critical scholarship within this field of inquiry.

Chapter 3 presents a theoretical and methodological overview of my ethnographic case study. The case study was done through a combination of ethnographic field work and semi-structured interviews with key informants.

Chapter 4 highlights some of the ways that the case study represented an innovation in engineering education. I also expand on the limitations of the case, as well as constraints on innovation in engineering education.

Chapters 5 and 6 delve into the ways that engineers in a British higher education context reproduce coloniality. Chapter 5 focuses on *practices* and Chapter 6 focuses on *discourses*.

Chapter 7 then goes in depth about one pedagogical approach to engineering education for social justice. One key component of the course - critical reflection – emerged as a powerful pedagogic approach in resisting the structures and episteme of engineering. This approach helped to challenge students deeply held assumptions and beliefs about themselves, their teammates and their project partners, leading to transformation within themselves and their approach to practice.

Chapter 8 returns to the question at hand – whether socially just engineering is achievable through engineering education – and works the question through a critically reflexive analysis, shedding light on possibilities for engineering education to contribute toward a more just engineering practice.

Chapter 1 – Literature Review and Case Study Context

Challenging the status quo: Toward engineering education for social responsibility

To challenge the engineering education status quo, there have been increasing calls within engineering education to re-contextualise the curriculum and embed social concerns, pushing outward the boundaries of what is considered valuable knowledge. According to an MIT report on the global state of the art in engineering education, there was agreement across an international roster of interviewees that social considerations will “emerge as hallmarks of the world’s best engineering programs” (Graham, 2018, p. 43). As mentioned in the previous chapter, engineering professional bodies have begun to institutionalise the connection between social and technical through accreditation criteria for degree programs. In the US, ABET requires students to receive “the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context’ and attain ‘an understanding of professional and ethical responsibility” (Zandvoort, 2008, pp. 133-134). In the UK, AHEP states that bachelors level students should gain “knowledge and understanding of the commercial, economic and social context of engineering processes” and the masters level should provide “an opportunity to integrate the technical and non-technical aspects of engineering and to develop a commitment to professional and social responsibility and ethical codes” (Engineering Council, 2014, as cited in Xavier et al., 2022, p. 69). Furthermore, in its most recent iteration, AHEP4, includes “learning outcomes that refer to mitigation of security risks and supporting equality, diversity and inclusion (EDI), in addition to sustainability, risk and ethics” (p. 69).

Despite the increased salience and importance placed on “social” perspectives within the engineering curriculum, the definition of “social” and the mechanisms by which social perspectives are incorporated in engineering education are highly variable and contested. One interview study, exploring engineering educator’s perspectives on what “social” means in the context of engineering, found a variety of interpretations. Many engineering educators define “social” in terms of “soft skills” or leadership and management skills, in preparation for “employability” (Xavier et al., 2022).

Nieusma and Bucciarelli (2015) suggest that reforms to the engineering education status quo must go beyond the “lack of graduates’ ability to communicate” or “to better understand the ‘impacts’ of technology on society” (p. 366). Instead, they challenge engineering education reform efforts to ask questions about whether we are “preparing our students to live a full life, as citizens...or are we preparing them to be merely ‘technical functionaries in support positions’ i.e., “guns for hire” (p. 366). They suggest that holistic reforms should relate learning with values and attitudes, norms, and beliefs, and should challenge the assumptions and mechanisms for transmission of knowledge. Upon reviewing a variety of different reforms in engineering education, they suggest that change is coalescing around the following agreements:

1. Education must go beyond mere “transmission of knowledge nuggets, discrete bits of material-like substance that can be passed from instructor to student in a way that is divorced from students’ experiences or their active participation in knowledge generation;”
2. It is inadequate to broaden engineering education, while maintaining the technical/social dualism “by, say, adding in occasional supplements from the arts, humanities, or social sciences, since such approaches rest on the presupposition that engineering and culture/society are somehow separable, distinct phenomena;” and
3. Teaching and research should complement one another and be used to inform one another. “...teaching and research not only inform one [an]other but [they are] also co-constituted in robust reform initiatives” (Nieusma & Bucciarelli, 2015, p. 366)

These approaches to reform have been taken up across engineering higher education. However, in many cases, they have been developed and implemented in isolation, or with more traditional engineering practice in mind. Transforming engineering so that macro-ethical concerns and social responsibility are central to practice will require a wholesale re-imagining of the curriculum, instead of isolated, piecemeal attempts.

Engineering to Help

Since the 1990s, efforts to drive more progressive and far reaching change in engineering practice and education have proliferated (Herkert, 2005; J. Lucena &

Schneider, 2008). Schneider, Lucena and Leydens offer “engineering to help” (ETH) as an umbrella term to characterise a variety of initiatives that centre around themes of “sustainable development, community service, service learning, and/or humanitarian engineering” (Schneider et al., 2009, p. 43). Other terminology that is used to define engineering to help programmes and initiatives include: engineering for social justice (E4SJ), engineering for sustainable development (E4SD), engineering for sustainable community development (E4SCD), and problem-based service learning. In addition to non-governmental organisations, such as Engineers for a Sustainable World (ESW), student organisations, such as Engineers in Technical, Humanitarian Opportunities of Service Learning (ETHOS), and joint student-NGO initiatives, such as Engineers Without Borders, there has been a growth of engineering education programmes in engineering to help (J. Lucena & Schneider, 2008). Taken together, these organisations, initiatives, and programmes aim to embed macro-ethical perspectives into engineering practice and the curriculum.

Some of these efforts culminated in 2004, when an international group of engineering educators, practitioners, and students, had a first meeting of what would become the Engineering, Social Justice, and Peace (ESJP) network. The network “promotes a vision of social justice that goes beyond helping vulnerable populations to identifying and confronting the *systems and structures that lead to injustices*” (Nieusma, 2013, p. 20). Over the years, this group has collaborated to deepen classroom-based and outside the classroom strategies to address social injustice perpetuated by engineering. In a review of educational and professional reform strategies that have helped advance social justice in the classroom, experiential learning; liberative pedagogies; advancing critical learning thresholds about social justice; and incorporating liberal education were identified as the most impactful (Nieusma, 2013).

Engineers were not the first to identify these strategies, however. In fact, they have common roots in John Dewey’s philosophy of experiential learning (Kolb, 2015). I briefly review and demonstrate the overlaps of these concepts in the following sections.

Theoretical and conceptual foundations of “Engineering to Help”

Experiential learning, or “learning by doing,” has its roots in the educational philosophy of John Dewey. Dewey developed his philosophy of experiential learning in response to what he called “traditional education,” characterised by the imposition of “adult standards, subject-matter, and methods” of learning onto young people (Dewey, 1938, pp. 18-19). According to Dewey, traditional education involved the teaching of “static,” or fixed material, with little regard to how the world is changing or could change in the future. This material is imposed on students, taught by rote means, an instrumental transaction of information in, information out, with little room for individual interpretation or creative expression. Critical to his theory of experiential learning involve learning where there is space for expression and the cultivation of individuality; freedom; making the most of present life; and the development and application of skills and techniques to make “vital” contributions to a changing world (Dewey, 1938).

Since Dewey published his philosophy, many of his ideas have made it into “traditional” education. There has been a revival of experiential learning strategies that date back to before Dewey, such as “apprenticeships, internships, work/study programs, cooperative education, studio arts, laboratory studies, and field projects” (Kolb, 2015, p. 5). In higher education, “internships, field placements, work/study assignments, structured exercises and role plays, gaming simulations...” are becoming increasingly common. However, those strategies do not necessarily overcome the boundaries of “traditional education,” and in some cases risk being overly “concerned with technique and process than content and substance” (p. 3). Kolb espouses experiential learning theory as an antidote to surface level applications, advocating a holistic approach to experiential learning for “lifelong learning and the development of individuals to their full potential as citizens, family members, and human beings” (Kolb, 2015, p. 4).

While Dewey was highly influential in shaping the concept of experiential learning, the work of Paolo Freire is also attributed to an active, experiential style of learning, often referred to as liberative, or critical pedagogy. Freire’s educational philosophy, however, advances a more radical conceptualisation of education as freedom than Dewey. He demonstrates how people are oppressed through a “banking

model” of education, and prescribes *praxis* as a methodology for using our innate human capacity to learn and applying it toward the active struggle against ideological and material forces of domination, with a hopeful striving toward emancipation from these forces (Freire, 1985).

Praxis involves *critical reflection*, or "reflection and action upon the world in order to transform it" (Freire, 1970, p. 51). Van Manen elaborates a definition of critical reflection as a form of reflection that “adds moral and ethical criteria, such as equity and justice,” and locates “analysis of personal action within wider historical, political and social contexts” (Fisher, 2003, p. 314).

The process and goals of experiential and liberative styles of education can help move students across critical learning thresholds. Threshold concept theory outlines five characteristics of “threshold concepts:” 1) they are “transformative”; 2) likely “irreversible” – once learners cross the threshold, they are unlikely to forget; 3) “integrative” – they help reveal the interrelatedness of a set of topics or issues; 4) “bounded,” for instance in helping learners understand disciplinary areas or academic “territories;” and 5) “potentially troublesome,” in that, by crossing a threshold, learners may find themselves encountering “alien,” “counter-intuitive” and/or incoherent knowledge that they may not yet have the perspective to manage within their established ways of thinking (Meyer & Land, 2003). The richness of experiential learning appears to enhance “social and moral development” (Bielefeldt et al., 2010, p. 536). In many cases, experiential learning through service exposes students to unfamiliar or uncomfortable confrontations with new and different cultures, life circumstances and perspectives, which can catalyse the crossing of critical thresholds.

Integrating liberal arts topics and modes of thinking into the engineering curriculum is another way to facilitate encounters with threshold concepts. The rationale for integrating liberal arts/liberal education into engineering education centres around the idea that hegemonic ideologies of engineering can only be broken down if more varied ontological and epistemological perspectives are integrated into engineers’ formation, part of which occurs during their time in higher education. Liberal education opens possibilities for critically questioning engineering knowledge and ways of knowing.

Models of “Engineering to Help”

There are several examples of educational models, courses, and standalone modules that incorporate many of the strategies described previously. In the US, one model that has gained prominence across several universities is the EPICS model. EPICS, or Engineering Projects in Community Service, is a framework for implementing engineering service-learning projects in the curriculum. The program is “vertically integrated,” meaning it enrolls students from first through senior years and allows students to earn course credits over multiple semesters of their degree programmes. Students have come from a variety of academic backgrounds, from engineering to sociology to English. Projects follow a five-phase development process, beginning with establishment of project partnerships, followed by the formation of student teams, and ending with the implementation of a product or service. Partnerships and project life cycles are maintained by students who join the team year-on-year. Students are supported by faculty advisors and teaching assistants. Their work is undergirded by taught modules, often taught by guest lecturers, and cover topics including engineering design, community service and communication (Jamieson et al., 2002).

Another example of a comprehensive curriculum is the Humanitarian Engineering minor at the Colorado School of Mines in the US. The training provided in Humanitarian Engineering results in a Bachelor of Science, with a minor in Humanitarian Engineering. The stated goal of the Humanitarian Engineering curriculum is to nurture “a new cadre of engineers, sensitive to social contexts, committed and qualified to serve humanity by contributing to the solution of complex problems at regional, national, and international levels and locations around the world” (Gosink et al., 2003, p. 1). As part of the minor, students can enrol in modules like “Engineering and Social Justice,” which “offers students the opportunity to explore the relationships between engineering and SJ through personal reflection and historical and contemporary case studies” (J. A. Leydens & Lucena, 2018, p. 171).

In addition to whole courses, ETH approaches can be found at the modular level. Kabo and Baillie report on the evolution of students’ thinking about social justice and its relationship to engineering after taking a module on engineering and

social justice at Queens University in Canada. The module was developed with critical pedagogy as its overarching theoretical framework. Students, who came from a variety of disciplines, were invited to critically reflect on common assumptions within engineering practice, and to consider “the creation of alternative practices which are non-oppressive, non-capitalistic, and ecologically sustainable” (Kabo et al., 2009, p. 129). Students were exposed to real-world examples of engineering injustices through seminars and a community-based group project. In their 2009 study, interviews and student self-reflections were analysed to better understand student perceptions of how the module helped them move toward the adoption of social justice as a critical lens. Results indicated that students evolved a more complex and nuanced understanding of engineering practice and its relationship to social justice, questioning the role of engineering in society and the “profit paradigm of engineering” (Kabo et al., 2009, p. 133).

In the UK, though there are few (if any) publications that delve into specifics of programme structures, curriculum and/or pedagogical approaches. This may be due to a lack of funding and/or a lack of institutional support for engineering education research (EER) within British universities. However, there are several programmes related to “Engineering to Help.” Warwick offers an MSc in Humanitarian Engineering; Cambridge University has an MPhil programme in Engineering for Sustainable Development; the Engineering and Design Institute London (TEDI-London) offers a BEng (Hons) and MEng in Global Design Engineering; Newcastle has an MEng programme in Chemical Engineering with Sustainable Engineering (Hons); Aston has an EWB Partnership that is committed to a Conceive – Design – Implement – Operate, or CDIO, approach, which reportedly “underpins” all of their programmes.

International Service Learning

International service learning (ISL) is a growing approach to experiential and problem-based learning within higher education (Mazzurco & Jesiek, 2014). Though definitions vary, it has been “conceptualized as the intersection of three different educational domains: (a) service learning, (b) study abroad, and (c) international education” (Bringle et al., 2011, p. 4). Bringle and Hatcher identify four important qualities of ISL: it is an academic activity, explicitly linked with the curriculum; the

service activities have reciprocal benefits between students and community partners; there is a reflective component, which helps students link service and educational content to produce learning; and “civic learning” is a desired learning outcome (Bringle et al., 2011).

ISL approaches can be found across disciplines, and range in duration and intensity from single modules to entire degree programmes. The majority of ISL programmes emanate out of the US, Canada, and Europe. Experiential learning through ISL has grown in popularity within engineering higher education, as a way to embed social and ethical considerations into the curriculum.

For instance, in 2009, the University of British Columbia (UBC) launched a new course, titled *Appropriate Technology in International Development*. The course is open to third- and fourth-year engineering students and is housed within the Faculty of Arts. The course is divided into two parts. The first part involves a series of lectures and tutorials designed to enable student discovery of the “values, attitudes, skills and knowledge required of global engineers in the 21st century” (Berndt & Paterson, 2010, p. 2). The second half of the course involves guest lectures and examinations of humanitarian case studies in India. At the time of publication, students also engaged in a community-based service-learning project within the Vancouver area. Future plans involved students engaging in ISL through direct engagement with community stakeholders identified in their case studies (Berndt & Paterson, 2010).

Alongside growing interest and implementation of ISL programs and projects in higher education, there has been a concurrent growth of critiques of these approaches. Critiques range from acknowledgement of failings of project implementation to arguments that ISL reproduces neo-colonial power relations.

Mazzurco and Jesiek (2014) developed a typology of failure, based on an exploratory study of eight case studies in humanitarian and service-learning engineering projects. They suggested failure amongst these cases fell within two realms: failure to learn and failure to apply knowledge. Within the failure to learn category, they identified issues of failure to assess needs, failure to understand culture, and failure to assess assets (Mazzurco & Jesiek, 2014).

An analysis of a multi-year water filtration project in Guatemala found that research outcomes were prioritised over social change; communication patterns reinforced cultural dominance of faculty and students; as well as “inherent limitations of ISL programmatic structures,” (Matthew et al., 2017, p. 1582) including knowledge gaps and communication barriers, stemming from high student turnover year on year.

Crabtree asserts that the weaknesses and dilemmas that emerge within ISL practice may be a result of a lack of strong theoretical foundations, in part due to the multi-disciplinary nature of educational ISL (Crabtree, 2008). Nieuwma and Riley (2010) contend that “in an eagerness to ‘empower’ local communities through development work, real power imbalances tend to be glossed over” (p. 53). Others argue that the foundational assumptions and beliefs that underpin service-learning are inherently problematic. Bruce (2018) suggests that these issues may only be addressed by deconstructing SL and ISL completely and building something new. In envisioning a post-critical service learning, she leads us to imagine an approach that is deeply relational – that the ideals, purpose and implementation of any service learning are co-constructed and constantly negotiated amongst learners (Bruce, 2018).

If we step outside of service-learning literature, however, and draw from participatory and community service literature, we can see that a post-critical approach has been attempted and has yet to achieve the goals of social justice. Indeed, Bruce acknowledges the potential limitations of her conceptualisation of post-critical service-learning as “difficult to implement fully within the curriculum time limitations,” prone to “romanticism,” and at risk of “adoption of absolute rather than contextual relativism” (Bruce, 2018, p. 207).

In the remainder of this thesis, I will explore if and how ETH through international service learning may (or may not) contribute toward a more socially responsible and just engineering practice.

Case Study Context

This study takes place at Swansea University, a public research university, established in 1920, in south Wales, United Kingdom. The Singleton Park Campus

housed the University's original two buildings and all academic colleges until 2015, when the new Bay Campus formally opened. At the time, the £450 million expansion of Swansea University with the Bay Campus represented one of the largest single investments in the knowledge economy in Europe (*£60 Million European Funding Boost for Swansea University*, 2012).

The two campuses are about 5 miles apart from one another. While the Park Campus is centrally located within Swansea's city centre area, the Bay campus has been set about 3-4 miles outside of the city centre, giving it a sense of remoteness. But it is more than just physical space that separates the two campuses. The majority of social science and humanities schools are based on the Park campus (with notable exceptions of medical and life sciences, due in large part to the co-location of neighbouring Singleton Hospital). The Bay, hailed as the "science and innovation" campus, houses the majority of engineering schools, as well as maths and computation (with a notable exception being the Management school) (Evans, 2015).

In one aspect, the development of the Bay campus, about 5 miles from the Park campus, reflects at least an unconscious acceptance of the separation between disciplines. At most, it reflects the power and politics of the hard separation between disciplines, with particularly high value placed on science and technology.

From its establishment, Swansea University "enjoyed close collaboration with industry." Franklin Sibly, the first Principal of Swansea University (then called the University College of Swansea), promoted "knowledge valorisation, turning knowledge into value and working alongside industry" (I. Davies, 2020, para. 5).

The science and engineering focus of the Bay campus furthered the university's industrial interests and connections. The campus was developed in close partnership with its land's former tenants – British Petroleum (BP). With their withdrawal from the Swansea region, BP reportedly sought to galvanize resources to "strengthen the capability of the region to innovate" (I. Davies, 2020, para. 13). The deal was spearheaded by a senior official at BP, who had attended Swansea University as an undergraduate student. The company donated the land and significant funding to Swansea University to build the campus (*Campus Close-Up*, 2015; I. Davies, 2020).

Within the current climate in higher education - one of increased competition for resources, aggressive moves to expand, etc - it is possible that the “gift” was seen as a strategic opportunity to advance the University’s global standing. However, the alignment of Swansea University’s senior leadership team with the vision of the BP official(s) to make the campus a predominantly engineering campus is symbolic of the underlying beliefs of Swansea University’s senior management - namely, that “science and innovation” deserves its own space, that it is acceptable that it is physically separate from the likes of the College of Arts and Humanities, and the College of Human and Health Sciences (now the School of Health and Social Care), and in general the liberal education of the University.

BP’s involvement in the building of the Bay campus is not the only symbol of the emphasis placed on engineering, science and technology at Swansea University. One of the primary goals of the campus infrastructure was to remove barriers to industry-university collaboration. In practice, this has meant that industrial partners have physical presence on campus, to the extent that industry and academics are co-located, “not only on the same site but in the same buildings” (I. Davies, 2020, para. 18).

The College of Engineering (CoE) (it has since become the Faculty of Science and Engineering, but I will refer to it as the CoE in this thesis) doubled in size as a result of the building of the Bay campus, employs about 1000 staff and trains about 4000 engineering students (I. Davies, 2020; *Head of College of Engineering Welcome - Swansea University*, n.d.). The College aims to develop students’ potential “to become future leaders and champions of industry, or to be equipped to meet the challenges and opportunities for a career in research” (*Engineering - Swansea University*, n.d., para. 2). Course offerings in engineering are generally divided along disciplinary lines. Undergraduate degrees are offered in aerospace, biomedical, civil, chemical, electronic and electrical, material science and mechanical engineering. Postgraduate degree offerings include aerospace, chemical, civil, communications, computational, electronic and electrical, materials, mechanical and structural. In addition to disciplinary-specific offerings, there are a number of cross-cutting and interdisciplinary degrees, including an undergraduate degree in general engineering, and MSc courses in engineering leadership and

management, nanoscience to nanotechnology, power engineering and sustainable energy, and sustainable engineering management for international development (*Our Engineering Courses - Swansea University*, n.d.).

My Research Context

As in most organisations, there are individuals who push the bounds of the status quo. Within the CoE, Andrew was one of those people. When I started working with Andrew, he had two titles - Associate Professor and Director of Internationalisation within the CoE. His role focused on teaching on one hand, and commercialisation for the College on another. His teaching responsibilities were focused within postgraduate schemes in engineering management and entrepreneurship. On the commercial front, he dedicated his role to cultivating a “diversified income for the College” (interview, March 27, 2018). Andrew seemed to have a lot of latitude to be creative in how he generated this income. In an interview, he admitted that he “wanted just to do stuff and do interesting stuff,” and he didn’t feel he was “restricted by a particular remit anyway;” as long as he was able to generate profit and “something good for the College,” it appeared that he was left to his own devices (interview, March 27, 2018).

And Andrew *was* able to cultivate profit for the institution. He had raised millions of GBP, especially through strategic partnerships with Chinese universities. These partnerships promised a steady stream of Chinese student attendance (and tuition payments) to the CoE, as well as roles for Swansea University staff to teach within Chinese institutions.

These big money deals gave Andrew latitude to experiment with other recruitment strategies, as well. His experimentation was largely informed by practice. Prior to entering into academia, Andrew had worked in industry. When he left industry, he maintained his contacts, and drew influence from those circles as he strategized how to support recruitment into the CoE. Through his industrial contacts, he got feedback that there were weaknesses and gaps in the traditional engineering curriculum, in particular, graduates were missing crucial people and project management skills (e.g. teamworking, self-management). During an interview, he talked about seeing those gaps, as well.

Andrew: ...When I was in charge of recruitment, it was something I identified then, we should have had in our portfolio, something on engineering management, as a recruiter for home/EU and International, so putting that together, I engaged a lot with industry again, with those mentors, those peers, and other people, and again can see some of the gaps...(interview, March 27, 2018).

Andrew was also involved in a number of “student mobility exercises,” including student volunteer trips to Zambia and Liberia. These trips gave students the opportunity to implement “some engineering and some engineering management in a very different environment” (interview, March 27, 2018).

During one of the student trips to Liberia, Andrew recognised students were not well-equipped to go into unfamiliar environments and work across cultures. This particular group had designed a trailer that could be attached to a motorcycle, which is a common form of transit in Liberia, and some of the only transport in rural areas. They had designed and built a prototype in Swansea and transported it with them to Liberia. It was only once they arrived and tested the prototype with community partners that they found out their stakeholders were not interested in the students’ design, as it was not fit for purpose.

Andrew used his experiences in Liberia and the feedback from colleagues in industry to address the dual aim of addressing gaps in the curriculum and increasing student numbers. In 2017, he started to develop two new Master of Science (MSc) courses – Engineering Leadership and Management (ELM) and Sustainable Engineering Management for International Development (SEM4ID). These programs departed from traditional courses, in that they were designed to immerse students in “real projects, with real stakeholders, real engagement and real money involved” (interview, March 27, 2018). The aim was to cultivate engineers who have a more holistic skillset, “beyond just being technically competent,” who are trained to ask critical questions about the implications and impacts of engineering interventions.

Recognizing the need for other like-minded engineering staff, as well as non-engineers to inform the design of the course, Andrew engaged others in the CoE, staff in the College of Arts and Humanities, the School of Management and the Prince’s Foundation, who got involved in developing the course structure, articulating learning outcomes, and teaching. Andrew also regularly engaged with

the Head of Academic Quality Services at Swansea University to ensure the new programmes would meet UK standards for academic quality, set out by the Quality Assurance Agency. Before the course was launched, the CoE built a business case for the course, which was reviewed internally by Swansea University's Programme Management Board and Programme Approval Committee, externally by external reviewers, and ultimately approved for student enrolment.

SEM4ID Course Structure

SEM4ID is structured into three semesters, over twelve months. All taught modules take place within the first two semesters, with the last semester dedicated to a final dissertation project. Taught modules span technical and liberal education topics, including project management, monitoring and impact evaluation, circular economy, and appropriate technologies (Xavier & Holness, 2018). There is also a community engagement module, taught by partners at the Prince of Wales Foundation.

The course has enrolled between 8 and 13 students each year from both engineering and non-engineering backgrounds, until the 2021-22 cohort, where all students were from an engineering background. The first year of SEM4ID, there were eight students, with six students from an engineering background (two civil, one product design, one chemical, two mechanical) and two with a social science background (two international relations) (Xavier & Holness, 2018).

Students engage in experiential, problem-based learning (PBL) through international service learning (ISL) projects. The locations of the projects have varied from year to year, but to date have taken place in Sierra Leone, Zambia, Liberia or Wales. Students are connected to previously established community-based contacts and take the lead in engaging with key stakeholders. Student group and individual research projects focus on a range of topics, which are negotiated between students, staff, and community partners. This work is scaffolded and assessed through their taught modules. For instance, students are required to develop a risk assessment for their international trips as part of their assessed work in a Risk and Resilience module. They develop their individual dissertations and group reports through a Concept Development module, where they learn research and design principles and receive intensive supervisory support.

In Years 1 and 2 after the launch of SEM4ID, students were assigned to teams early in the year, to ensure representation from diverse disciplinary backgrounds. They worked together to understand their community partners' needs and assets. They had a chance to meet partners in person during a short scoping visit (approximately 1 week), about mid-way through the 12-month course. They then engaged in an iterative design process where they developed an engineering intervention, pitched their proposals to community partners and Swansea University stakeholders, and, depending on the strength of their proposals, received funding toward implementation. Toward the end of the year, students travelled back to field sites to test and implement their designs.

Year 1 Student Projects

Student projects in the first year of the course evolved throughout the academic year, in response to feedback from academic advisors and community partners, due to unforeseen external circumstances, and the evolution of the students' thinking.

At the outset, one team of students were focused on a community cooker project. This work was led by the Community Cooker Foundation and supported by the Prince's Foundation. The Community Cooker Foundation is a non-profit organisation based in Nairobi, Kenya, which has developed and implemented a design for a community cookstove. The cooker is intended for use within rural and/or informal settlements, and is designed to burn rubbish for baking, boiling water, and cooking (*Community Cooker*, 2012). Initially, SEM4ID students had been asked to explore ways of "diversifying the energy outputs" from a cooker in Kenya. However, due to political unrest in the country in 2017-18, students were re-routed to a new community cooker implementation project in Sierra Leone. This cooker was to be based within Destiny Village, a slum relocation project, founded by Home Leone, a non-profit organisation dedicated to the "end of slum living in Sierra Leone" (Destiny Village, 2022, para. 1).

The Zambia team was initially working on developing a classroom building for children with special educational needs (SEN) at the Siavonga Primary School, in the south of the country. Like the Sierra Leone team, the Zambia team projects

evolved due to a variety of unforeseen circumstances, and after alternative project pathways were identified.

Unlike the Sierra Leone team, where the relationship between Swansea and their community partners (Community Cooker Foundation and Home Leone) were new, relations between Swansea and Siavonga predated involvement of CoE students and staff. The original connection between Swansea and Siavonga was established by Christine Watson, the Manager of the Discovery Swansea Volunteer Service. In 2008, Christine travelled from Swansea to Siavonga to volunteer with the Siavonga Nutrition Group (SNG), through the Welsh Government and Voluntary Service Overseas (VSO) - Zambia.

After a short-term volunteer stay, Christine remained actively engaged with members of the Nutrition Group and helped organize the development of a partnership between Swansea and Siavonga. In 2010, this partnership was formalized through a Memorandum of Understanding (MOU), signed by the Lord Mayor of Swansea and the District Commissioner for Siavonga (*Swansea-Siavonga Partnership / Who We Are*, 2022).

The Zambia team worked closely with the current lead of the Nutrition Group (I will refer to them as G). G worked closely with Christine Watson to launch the Swansea-Siavonga Partnership and still maintains responsibility for coordinating the Partnership and managing the Siavonga Nutrition Group. According to G, the main goal of the Swansea-Siavonga partnership was to “bridge the gap” between the two towns. During the formation of the relationship between the two towns, there was recognition that most of the vulnerable people are women and children. This was “despite that it is the Western world, but there are people who are poor, who are also vulnerable.” (interview, August 15, 2018).

The Siavonga Nutrition Group, according to its Facebook page is a “non-profit, community-based organization whose aim is to assist in improving nutritional conditions and food security for the villages, peri-urban and urban areas of Siavonga, Zambia. Founded in 1982 by a Danish doctor “after observing that large numbers of children were dying of malnutrition related diseases” (*Siavonga Nutrition Group - About*, n.d., para. 1). “The group initially provided nutrition education to mothers of

malnourished children and founded a skills training centre,” (para. 1) where they were taught agricultural and other income generating skills. Today, the SNG runs workshops and other interventions for women, focused on a number of themes, including health and nutrition education, livelihoods (i.e. group savings and income generating activities), agriculture and sustainable farming (*Siavonga Nutrition Group*, n.d.).

Chapter 2 - Methodological Narrative

Introduction

This chapter provides a narrative account of my journey of wrestling with critical theories and methodologies in the context of engineering education and engineering education research (EER). The context of this journey is exemplified by the parallel, yet often separate, discussions in engineering education research (EER) on one hand, about methodology, and on the other, about injustice in engineering and how it may be perpetuated within engineering education.

Early EER focused on description, but more recently, in response to calls for innovation in the engineering curriculum, there has been an effort to distinguish the field as a site of rigorous scholarship (K. Beddoes, 2014). In response, there has been a proliferation of methodologies, including mixed methods, and advanced qualitative methods, such as ethnography, discourse and narrative studies (Case & Light, 2011). Despite these calls, the field still grapples with disagreements in priorities, research questions and a wide variety of methodological strategies, and with them, varying epistemological approaches and demands (K. Beddoes, 2014; Borrego et al., 2009; Case & Light, 2011; Walther et al., 2013).

A parallel discussion within EER has questioned *what* and *who* is engineering for (J. A. Leydens & Lucena, 2018). It has highlighted inequities in engineering writ large; for instance, the lack of opportunity in engineering education and practice for those who are not the “typical engineer” – namely those who are not white, straight, able bodied, cis-gendered and male – and the downstream consequences of a homogenous cohort of engineers who ultimately design and build for a much more diverse general population (K. D. Beddoes, 2012; Slaton, 2015). This conversation has largely focused on how, as a *teaching community*, we change engineering education to foster a more just practice (J. Lucena et al., 2010; J. C. Lucena & Leydens, 2015; D. Riley, 2008; Winberg & Winberg, 2017).

At the intersection of these two dialogues exists work to identify where and how we reproduce hegemonic and ideological norms as a *research community* that may be contributing to inequities and injustices. This interrogation has led to a push for the development of critical scholarship in EER. Deepening a critical approach

holds the promise of helping us interrupt the reproduction of hegemonic norms, practices and beliefs within our scholarly endeavour that may contribute to the injustices we seek to rectify within engineering practice (D. Riley, 2008).

Pawley does this in a study on ruling relations within the structure of US engineering education. She demonstrates how we can pair empirical qualitative data with feminist theoretical frameworks to critically analyse social relations in engineering higher education and how they may contribute to a lack of representation of men and women of colour and white women in engineering (Pawley, 2019). However, though the number of studies employing critical research frameworks appears to be on the rise, it is rare that they are applied to interrogate how knowledge and identities are constructed in engineering, or to facilitate liberative action, which some might argue constitute the core demands of critical scholarship (Mejia et al., 2018).

What stops us as a field of scholarly practice from advancing a critical methodological approach, toward our collective aims of addressing inequities *and* advancing research? The challenges of and barriers to implementing a socially just engineering curriculum or enacting critical pedagogy within engineering classrooms has been explored by a number of engineering education researchers (J. C. Lucena & Leydens, 2015; D. Riley & Claris, 2009; D. M. Riley, 2013). However, there has been less discussion about the barriers to doing critical scholarship within engineering education research itself.

To contribute to our understanding about the ways that structural factors may play a role in prohibiting the advancement of critical scholarship, I provide the following critically reflective account of the challenges and barriers of doing critical qualitative research in our engineering education research context. My aim is to shed light on some of the structural barriers in doing critical research in engineering education research. As Kincheloe and McLaren write, this process of “shedding light” aims to unravel “the ideological codings embedded in...everyday life” (Kincheloe & McLaren, 2011, p. 297). In doing so, I hope this offering will help us better map the areas of our scholarly practice that require additional development as we deepen our understanding and application of critical methodologies.

My positionality

I start this methodological narrative by outlining my position to the research. I liken this self-reflexive approach to Ropers-Huilman's concept of "witnessing" (Ropers-Huilman, 1999). The process of witnessing, according to Ropers-Huilman, is part of the ethics, or the "obligation" of doing such research. As a qualitative, social researcher, I am a witness to particular social scenarios, but I am also part of creating those social scenarios. My presence indelibly effects the research I am doing and the participants I am interacting with. By sharing some insight about who I am in relation to the research, I disclose some of the ways in which my interpretive lenses have developed and potentially impacted the research environment. I use this "confessional tale" to explore how my own experiences awakening to systems and structures of oppression, and my position within them, may have inflected on my experiences within the research environment and my interpretations of those experiences (Ellingson, 1998). This exploration is not intended, however, as a validity claim, but, as Ellingson reflected of her reflexive approach, my intention is to "reassure the reader that my findings are *thoroughly* contaminated" by the rich complex perspectives I have developed from my life's learnings (Ellingson, 1998, p. 494).

I start my story 2016, when I moved to Swansea, Wales, from the United States. I had been working as a manager of health advocacy projects in the US, but had been working on a career shift, to focus on organizational development. After working for mission-driven organizations for many years, I started to see how these institutions were often hampered by a lack of self-reflection and self-improvement. I wanted to put my efforts into better understanding organizational cultures and working to facilitate organizational learning and change, so that those institutions would be more effective at contributing toward wider social betterment.

I met Andrew through professional networking, and as we exchanged ideas and professional histories, it became clear that we had a lot in common. We were interested in leaving the world better than we found it, therefore, we have directed our careers to apply ourselves in ways that align with our values. However, along the way we have both encountered organisational frustrations, as we see problems but

often feel constrained in our ability to resolve them, due to bureaucratic and other institutional barriers.

So, when Andrew suggested I apply for a PhD to work with him, to interrogate some of the organisational challenges in his university, why he and some of his colleagues were facing some of the barriers to change that they were facing, I thought it was an interesting offer, one that I did not refuse. After gaining entry, I started my PhD studies at Swansea University in the College of Engineering in January of 2018.

During early conversations with Andrew about my research, I noticed those conversations would often focus on the SEM4ID course. After applying for and gaining necessary ethics committee approvals, Andrew helped me access the inner workings of the course, as he was heavily involved with its development and with the students who had enrolled. Andrew would often pull me into his office to discuss various aspects of the course – the students, their projects, the course content and assessments. He also drew me into regular meetings he held with students and staff involved with the course.

The SEM4ID course was promoted as an innovative change in the way that engineers are trained. Indeed, it was held up as an example of innovation by the Institution of Engineering and Technology and the Engineering Professors Council (*New Approaches to Engineering Higher Education*, 2019). But was this course truly innovative? Was it doing something bold and different, as it was being sold? I came to learn that there was not a straightforward answer to this question. In many ways, SEM4ID was pushing the boundaries of standard higher education. The course was implementing innovative pedagogical styles, including experiential and problem-based learning, high levels of student engagement in the learning process, and team working. There were also many interesting curricular approaches, including interdisciplinary course work, design, and critical reflection. This boundary pushing was not without limitations, but overall SEM4ID was a learning space, where teachers, students, and researcher (myself) were all learning from one another and from our shared scenario. I will explore these themes in Chapter 4.

However, I also started to recognize that in doing “international development” through ISL projects in post-colonial nations, staff, faculty and students were directly confronted with the not-so-distant past, and the neo-colonial aftermath, “in the sense of remaining economically and/or culturally dependent” (Loomba, 2002, p. 7). This confrontation surfaced tensions, discomforts, assumptions, and biases, which may otherwise have gone unsaid or unnoticed. Through this real-world confrontation through their projects, alongside with rigorous critical reflection, students and, by extension, faculty, had to reckon with some of the neo-colonial dimensions of the interaction between a British higher education institution and community stakeholders in post-colonial nations.

This was not the first time I had been confronted by and reflected on histories of injustice, imperialism, and colonisation and how those forces have helped shape the world we live in today.

Early critical consciousness development

From a young age I remember having a robust conscience. One of my first memories was going to the beach and instead of playing, I remember being concerned about the environment, stressed at seeing litter strewn everywhere. I remember digging a hole in the sand and asking my parents for pen and paper so I could write a sign for my makeshift trash bin, directing passers-by to put their trash in that hole, rather than carelessly leaving it all over the beach.

In reflecting where this consciousness comes from, I consider my Jewish background to have been formative. Our parents raised my sister and I in the Jewish faith, albeit a relaxed and secular form. We did uphold some traditions of the faith but being Jewish felt less about being religious and more about being part of a community, and furthering the line of a long, rich, yet tormented ancestry. At religious school, we learned the ancient language of Jewish people, alongside the values, traditions, and holidays. But we were also told stories of how Jewish people have been enslaved, ghettoized, ostracized, and systematically murdered. As I got older, I came to understand that the trauma of the Holocaust was not something ossified as part of history. My maternal grandfather was a survivor yet died young due to illness we believed to be from toxic exposure while enslaved in a German

labour camp. The void created in my mother's life when my grandfather died echoed through my life, as well.

Being deeply sensitized from a young age to the injustices that humans are capable of perpetrating unto others, not as some abstraction of history, but from a close personal perspective, understanding how injustices create injury and trauma, has made me deeply empathic about the pain and suffering of others. It has also driven me, not just to understand that trauma, but to work to understand the root causes and generative mechanisms of injustice, to understand whether solutions or course corrections are possible, and where they may be possible, to understand how to implement solutions.

As I grew up, this consciousness manifested within my career ambitions, which, by the time I went to university, were simply and, in hindsight, naïvely, to become a doctor, travel and “help people.” Along the way, I spent time volunteering in Ghana and Honduras. I took classes in engineering for sustainable development. My first trip to a “developing nation,” would, however, lead me to question everything I thought I knew about the dichotomies between my world and “theirs,” and about who needed help and who were the helpers.

While I do not remember having much in the way of expectation, I do know that I went off with some sense of purpose - to “help” people who were in need. But what I found when I arrived, were people living their daily lives, experiencing the full range of what it means to be human, albeit in a somewhat different context and way than I was. These were not people waiting for me to help them. I met people who I befriended, who looked out for me, as I walked through town, who taught me the local greetings and handshake. They were not worse or better; in some ways we were very different, but in a lot of ways, we had a lot in common.

These experiences helped me start to re-formulate my conception of “need.” I began to ask critical questions about the images and narratives I had been fed about those from “developing” parts of the world. Why were there videos of “poor Africans” who needed “our help” on the television growing up? I learned that my desire to “help” was misplaced, and potentially guilty of reproducing power relations between “us” in “developed” nations and “them” in “developing” nations. Before I

had immersed myself in other communities and cultures, I had unknowingly, yet uncritically bought into a “White Savior Industrial Complex,” and the assumptions that “they” need “our” help (Cole, 2012).

I continued this line of questioning through further education and professional pursuits in international development. I became increasingly uncomfortable with the conceptualizations of developing vs. developed nations, and “aid” and “charity” work. Upon interrogating those feelings, I began to learn more about the about the history of colonisation, and how even after colonisation in governmental form, post-colonialism only brought a new form of economic imperialism that lives on today (Loomba, 2002). I learned that the “developing” nations as we so call them in the West are the way they are because *we have made them* (Rodney, 1973).

Putting myself and my experiences in the context of historic power relations influenced my approach to professional practice, including a decision to step away from international development practice for many years. In hindsight, this was one of my earliest formative experiences in doing critical reflection.

Early problematizations

This was the lens that I imported as I became embedded within the evolving social scenario surrounding the SEM4ID course. However, in the early days of my doctoral studies, my research questions were unclear, which is typical in qualitative social research (Carspecken, 2013). Because I had been shadowing Andrew and for several weeks, had attended some of the student presentations and meetings, I had become familiar with some of the issues, concerns, and dynamics with the College of Engineering and, in particular, within the SEM4ID programme. I sensed that this familiarity may be biasing my view of what were the most important areas for research investigation. I did not want to move too quickly to define a problem before I had spent enough time observing and gaining a more holistic picture of the social situation. I wanted to explore some of the various concepts that Andrew and I problematized in our ongoing conversations, but I wanted to remain open to seeing what I would find when I started collecting and analysing data.

I initially decided to use Glaser and Strauss's grounded theory as a methodology to support an inductive approach to *developing* theory. The original conceptualisation of grounded theory suggested the researcher approaches the social scenario under investigation as a *tabula rasa*, or blank slate. The researcher is meant to follow a systematic approach of theoretical sampling to generate conceptual categories and their properties, or generalized relations among categories and their properties from the data. These categories and their relations form the building blocks of theory. In parallel, the researcher uses constant comparative analysis to compare emergent theory with the data, to ensure the categories "fit" the data, and help direct additional data collection needs (Glaser & Strauss, 1967).

Grounded theory emerged out of critiques of social research relying too heavily on the process of *verification* of theory. Glaser and Strauss argued that much social theory was developed separately from data and that many of the "grand theories" that dominated sociology at the time "do not fit, or do not work, or are not sufficiently understandable to be used and are therefore useless in research, theoretical advance and practical application" (Glaser & Strauss, 1967, p.11). Furthermore, they contended that the reigning theories at the time were insufficient to "cover all the areas of social life that sociologists have only begun to explore."

In developing a methodology for systematically *building* theory, Glaser and Strauss were proposing an alternative pathway for social researchers to resist the unquestioning acceptance of "great-man" theories and expand on the repository of theory to help us better understand our social world. In particular, they offered grounded theory as a methodology for cultivating theory from *qualitative* data.

Grounded theory seemed a way for me to systematically characterise what I was observing in the social scenario. Instead of deciding on a pre-determined problem frame and designing surveys or evaluations to test hypothesis within that frame, I could be expansive and exploratory about the social situation, collect qualitative data, and lean on a strong analytical approach to building new insights. I believed this approach would help resist reductionism, that I would miss some of the most interesting aspects of the problem or frame the problem in a way that would potentially be too narrow or theoretically uninteresting.

My plan was to use ethnographic methods of observation, interviews and other qualitative data collection, and apply grounded theory's constant comparative method to generate theory that would help me develop a more complete picture of "the problem" in engineering education at Swansea University. According to Spradley (1980), ethnography is the study of people and their culture, the artefacts and symbols that make up this culture, and the meaning behind them. Ethnography first starts with identification of a social situation and often begins with an open style of questioning early in the research process. This approach allows the researcher to follow the story where their interest and the interests of their academic community might direct.

Armed with ethnographic methods and grounded theory to guide my analysis, I started my doctoral work with an open question – *what is happening here*. I used active listening to help me home in on potential areas of interest for deeper interrogation, and spent time familiarizing myself with various literature, based on what I was hearing.

However, during some of the meetings I attended with SEM4ID students and staff, I got some insight into how the course was being run and managed and I started to have some concerns. For example, I became more embedded within the course at a moment when students were proposing their final design projects. If their proposals were successful amongst a panel of advisors and staff in the University, they would be granted some funding to proceed with implementing their designs in the field. My first concern was that the turnaround time was very fast, potentially too fast, for students to receive funding to implement an engineering design in the field. At that point, students had been enrolled on this course for just six months. Based on my experiences working in international development and community engagement, I expected the students would have needed to at least build meaningful relationships with community partners, conducted appropriate assessments, and conceptualized an appropriate technical design that was socially and environmentally sensitive, before being given the go ahead and funds to implement the design. I thought it was unlikely this level of work had been achieved in the time that the students had been on the course.

As I became more embedded, I became vocal about some of these concerns. Andrew encouraged me. The course was evolving, and he was happy to take on board some of my suggestions. It was the first year that the course was run, and there were a lot of kinks to work out.

I continued asking the question of *what is happening here*, to develop a stronger sense of the context I was in. But I also started asking bigger questions about how we were approaching “change.” I became curious to know if this British institution of higher education has the potential to be a change agent in society, or does it need to be changed to be an ethical actor in this space? I wanted to better understand the nature of the course, how students and staff interacted with it and through it in light of these bigger questions. Only then might I start drawing conclusions about whether or not certain aspects of this course might start to lead to a more just engineering practice.

These research questions, however, led me to start critically questioning my initial approach to my research. I could no longer proceed with grounded theory, knowing that I was not a “blank slate.”

Recognizing this sent me down a path toward making sense of my research process to date, which, up to that point had eschewed a particular theoretical grounding, in favour of an inductive, grounded approach. I found critiques of the original conception of grounded theory and significant work to re-conceptualise it within a constructivist frame which works on the premise that we generate theory from the data, though it creates space for us to make explicit our biases and positionality upfront (Charmaz, 2017). Strauss himself later came to acknowledge the issue with the “blank slate,” and along with Corbin acknowledged that researchers carry “the sensitizing possibilities of their training, reading and research experience, as well as explicit theories that might be useful if played against systematically gathered data...” (Strauss & Corbin, 1994, p. 277).

At the same time, I was learning from critical qualitative scholars that one’s theoretical sensitivities can be wielded for meaningful purpose. Alvesson argues that closeness with the research subject may lend itself to developing more interesting empirical material; the insider may have better and deeper access to the social

scenario and may be able to produce theory that is “more well grounded in experiences and observations” than an outsider (Alvesson, 2003, p. 178). A critical approach to ethnography, in particular, meant that I needed to actively take note of where my experiences might help me see what otherwise may have gone unseen.

This felt like a particularly important part of my process as a social scientist working within the context of engineering; I realized that we were bound to have fundamentally different theoretical sensitivities and that, when I ask the question of “what is happening here,” I may potentially be able to uncover what may otherwise be “unseen” to the engineer.

With this realization, I made a conscious shift, embracing my *a priori* knowledge theoretical sensitivities, moving toward a more critical, reflexive approach to ethnography.

Challenges of embracing critical scholarship in engineering education research

As I leaned into this work and my research process began to feel surer to me, I started running into some resistances amongst colleagues, particularly my engineering colleagues. I received feedback on a growing number of occasions that I needed a clear research question, a hypothesis, and more “data.” One of my engineering supervisors was concerned that I was “not getting into an engineering mindset enough.” They also admitted that they liked to see “the data,” implying something quantifiable and quantified. Another mentor in EER admitted they viewed hypothesis driven research as a better way to advance a career in academia. That same mentor suggested I potentially re-focus my research toward the development of an intervention. Indeed, even when submitting the abstract for this paper for peer review, I received feedback that I was lacking a hypothesis.

Each time I was encouraged to shift my methodology to something that was testable, verifiable, or to create a neat package that could be used by practitioners, it led to a cascade of critical questioning about research process and methodology. Though I was fortunate that each time I spoke with my supervisors, they were encouraging of my progress and the insights I was generating. My management supervisor, in particular, consistently nudged me back toward the critical, interpretive project I had embarked on.

However, I still felt I was standing at a crossroads. One direction would lead me to shift my approach to my study by developing a hypothesis that I would then test. I could see various benefits to taking this road; namely, I would be following the advice of some of the more senior engineering academics who were providing me with feedback and guidance. I also had familiarity with hypothesis-driven research through my public health education, therefore there was an allure to move toward the familiar.

The other direction was a road less sure – continuing and ultimately completing a research study that was critical, inductive, and qualitative, without firm support from some of my advisors and peers. This was the road that I had embarked on from the early days of my doctoral research - I was steeped in methodological literature on critical scholarship, ethnography, and inductive qualitative research, which were all pointing me away from hypotheses testing and toward theory development.

It was during a conversation with my management school supervisor that it hit me – a reason why the crossroads exist at all may be related to how knowledge is valued differently within different research communities. My engineering supervisors seemed to be consciously, or quite possibly subconsciously, driving me toward a positivist paradigm. And I was susceptible to that pressure due to my formative training in positivist methodologies.

This came up yesterday, like a lightning bolt, during my conversation with [management supervisor]. I realized that the pressure for me to hypothesis test is coming in part from my own ontological beliefs that a one single truth is out there to be found, as long as we design a good enough experiment and test it well enough (reflection, March 15, 2019)

As I reflected critically on this realization, I started to see my conundrum echoed within a much broader context of an ongoing discourse in social research on the relationship between positivism and interpretivism.

There are myriad books and articles dedicated to this discourse (for instance, (Denzin & Lincoln, 2008; Ritchie & Lewis, 2003; Schwandt, 1996), so I will not try to detail it here. The main crux of arguments between interpretivism and positivism involve the position and subjectivities of the researcher. As mentioned in the

Introduction to this thesis, Positivism carries the epistemological position that there is an objective truth that is discoverable through systematic interrogation. Hypothesis testing through the scientific method has been and still is the main procedure within positivist research. And theoretically, it is through this procedure that the researcher remains invisible to the research. Interpretivism departed from positivism as it became increasingly untenable to ignore the influence of the researcher within the research process. Modern day (post-modern) interpretivist research has fully acknowledged the subjectivity of the researcher and has absorbed this stance into methodology (Denzin & Lincoln, 2008). Much of interpretivist research involves “thinking more about how to bring oneself into the research process” (Cousin, 2010, p. 4).

Tensions and conflicts abound between positivists and interpretivists due to their fundamental epistemological differences. Whereas positivists see interpretive projects as “fiction, not science,” and a fundamental attack on truth, interpretivists see positivism as “an attempt to legislate one version of truth over another” (Denzin & Lincoln, 2008, p. 8).

However, despite widespread agreement across social science and humanities about the importance and validity of the researchers’ perspective within the research process, interpretive research is largely marginalized within scholarship. Schwandt argues however, that this has less to do with the epistemological debates amongst scholars and more to do with the current neoliberal politic impacting the research environment (Cheek, 2008).

“As explained by Taylor (1987) and Sullivan (1986) in different accounts, the enduring power of the belief in social scientific reason is in fact less attributable to the success of epistemological arguments for naturalism in the social sciences and is more a result of the pervasive power of the moral-political ideals of disengagement, instrumental reason, and atomism to which it is bound” (Schwandt, 1996, p. 61).

The politics of research thus entrench positivism as a dominant epistemological position, and reify hypothesis-driven research (Denzin & Lincoln, 2008).

As Schön describes, positivism is an entrenched position within professional and research institutions, including engineering. As the majority of engineering education researchers are engineers by training (Borrego & Bernhard, 2011), it is no

surprise that positivism has been identified as a dominant research paradigm within engineering education research, as well (Douglas et al., 2010; Johri, 2014; Walther et al., 2013). Gadamer theorized that “social frames of reference influence researchers’ questions, which, in turn, shape the nature of interpretation itself” (Kincheloe & McLaren, 2011, p. 296).

Identifying my experience within these layered contexts of methodological discourses in social science, more generally, and within EER, specifically, was a powerful one and served as a critical incident for me as I advanced my research. If I wanted to proceed with the work I had started, it meant I would need to stand my ground against some of my advisors’ suggestions, which at the time, felt intimidating. However, I began to recognize that if I didn’t proceed on my own terms, I would continue to be tempted to change course and being swept up within the reigning positivist paradigm.

That said, I did not move away from positivism due to a value judgement against it. Instead, it was important for me to learn about this discourse, to acknowledge the challenges of departing from a dominant research paradigm and to move toward a scholarly practice that is marginalized in many ways. I will use the remainder of this chapter to explore some of those challenges and barriers to doing critical, interpretive research.

Tensions between critical and positivist paradigms

Critical research exists within the interpretivist umbrella but comes with distinct theoretical frameworks and demands that layer onto the interpretive lens of the researcher. A critical stance entails explicitly acknowledging the social, political and economic forces that are “inscribed in organizational arrangements, social relations, and in every perception” (Alvesson & Deetz, 2000, p. 18). “Inquiry that aspired to the name *critical* must be connected to an attempt to confront the injustice of a particular society or public sphere within the society” (Kincheloe & McLaren, 2011, p. 300). The inherent demands of critical research thus put it in direct confrontation with the objectivist, value-neutral position of positivist research, and therefore, by extension, much of engineering education research.

For the engineering education researcher who resists positivist pressure, and embarks on a critical research endeavour, there are additional challenges. First, it is time consuming. Johri acknowledges the time intensiveness of interpretivist research (Johri, 2014). In work to develop a feminist thermodynamics curriculum, Riley and Claris (2009) acknowledge that “the biggest obstacle to implementing...[critical] pedagogies is the time and energy investment” (p. 42). But doing critical research goes beyond the regular demands of an interpretivist empirical project, as it not only requires knowledge and skills in methodology, but a wide breadth and depth of theoretical knowledge, as well. As Alvesson and Sköldbberg (2017) warn, “to a certain extent perhaps the heavy demands on the critical theorist to be well read and theoretically sophisticated can take so much time and energy that there is little left for absorbing interesting impulses from empirical material” (p. 136).

Furthermore, critical scholarship is not just one thing. Critical theory was conceptualized within the Frankfurt School and involves theory-driven critique of our social world. This form of critique has been applied within feminism, postcolonial studies, indigenous studies, critical race theory and other theory-driven scholarship. It has also been applied to empirical methods, such as ethnography and discourse analysis. It has also informed practice, as within critical pedagogy. However, even pinning down the concept of critical theory or critical social research is challenging, as there are many debates and discussions within the field about its nature and purpose. This only makes the learning curve in finding oneself within the methodological landscape that much steeper, and thus would require that much more time.

In the UK, a typical doctoral project only has 3 years of funding, and 4 years total to finish a degree (the 4th year is an unpaid “write-up year”). In my case, the slow pace of doing critical interpretive work has been a disadvantage. It has taken me 3 years to really come to understand some of the most important threshold concepts that will contribute to my thesis.

For engineering education researchers who largely exist in a positivist research culture (J. Leydens et al., 2004), the time requirements to do the deeper scholarly work involved to interrogate their epistemic beliefs, depart from the dominant culture, and learn a new discipline, or at least a new set of methodologies,

may pose too steep a hurdle to overcome. In the earlier days of our working relationship, this seemed to be the case with one engineering supervisor, who joined my supervisory committee mid-way through my doctoral studies.

... I see [engineering supervisor] moving toward EER but maybe not having the time to develop the breadth of methodologies that are being used in this space (or potentially could be used in this space) and therefore leaning back on what she knows (reflection, April 4, 2019)

Riley, in her reflective piece on advancing social justice within the classroom, admits it was a ten-year project (and still ongoing) involved in more securely enacting a critical pedagogy in her classroom, and developing a more socially just curriculum. And she discusses how time constraints are a barrier to doing reflective work involved in becoming critical and resisting dominant institutional and cultural norms within engineering higher education (D. M. Riley, 2013).

My supervisor, mentioned in the quote above, has devoted a significant amount of time and resources over years to developing a critical lens to her teaching and research practice. This has been possible, in part, due to her permanent position within the University, which has allowed her to take more risks with how she spends her time. However, this is unlikely to be possible for all EERs, particularly those who have more tenuous contracts or are not yet tenured.

Time has become an increasingly precious resource for academics around the world, fuelled by the marketization and commodification of higher education (Canaan & Shumar, 2008; Wint & Nyamapfene, 2022). In the UK, the embracing of business practices within universities, which were formerly public entities, has brought with it a tendency toward “new managerialism.” ‘New managerialism’ is characterized by “a heavy emphasis on importing ideas and practices from the private world of business into the world of public service, on the assumption that the latter are superior to the former” (Deem & Brehony, 2005, p. 220). This has had significant impacts on academics, as they have become “labour” within a market-based system, and transformed from “communities of scholars” to “knowledge-workers” (Deem et al., 2007). The academic institution under new managerialism has brought with it “new kinds of imposed external accountability, including the

widespread use of performance indicators and league tables, target-setting, benchmarking and performance management” (Deem & Brehony, 2005, p. 220).

“With this increased demand for accountability has come a corresponding increase in focus on management, often above all other activities; monitoring employee performance (and encouraging self-monitoring too); the attainment of financial and other targets, devising means of publicly auditing quality of service delivery and the development of quasi-markets for services” (p. 220).

In this environment, “efficiency and effectiveness are extensively pursued in the field of service delivery” (Deem & Brehony, 2005, p. 220).

The discourse of new managerialism “is heavily inflected by technical metaphors, many borrowed from engineering, such as ‘best practice’ and ‘business process re-engineering’” (Deem & Brehony, 2005, p. 223). Is it possible that being steeped within an institutional discourse that echoes their training makes engineering education researchers more susceptible to accepting new managerialism as the norm? If so, it may make it even more difficult for the engineering education researcher to even identify institutional structures that restrict one’s ability to learn new ways of being and knowing.

Though I go into depth here about the potential impacts of “new managerialism” on our ability to take on new scholarly projects, I recognize there are many other mediating factors and potential explanations.

Even before we became engineers or academics, we were students within the modern education system. Critical pedagogy is a theoretical framework that outline the degree to which we must work to resist the norms of the modern academic institution in order to free ourselves to do critical projects. Throughout our education, we have rarely, if ever, been asked to critically examine the fundamental nature of our reality; to confront power in meaningful ways; or to question why and how we value knowledge. Embracing and enacting criticality is not something that can be learned solely from reading a textbook, and most of us have not been raised with an embodied understanding of it or how to do it for meaningful analytic purpose (Freire, 1970; Giroux, 2011; hooks, 1994).

From my experience, I believe that strengthening our theoretical underpinnings, and regularly communicating them within our methodological

discussions may have helped me better navigate the perilous waters of critical scholarship and support my doctoral research. To help build a generation of critical scholars in EER, we need to build stronger scaffolding, by excavating and expounding on theory, communicating it effectively, and demanding it from our students and one another. But first, we must acknowledge the boundary conditions we exist within and engage in the activist project of pushing for more space within universities for deep and meaningful learning projects. Though this work is already underway in many places, we must continue expanding its bounds.

Arriving at Theory

My arrival at theory came with its own set of challenges. Doing ethnographic field work without a firm theoretical framework as a starting point meant I had nothing to help me narrow my researchers gaze, and the amount of data I could have collected was infinite. After 2-3 days of intensive fieldwork, where all of my observations felt like they could be potential starting points for further inquiry, I was completely overwhelmed.

Dr. Decoteau (2010), in her lecture on Realist Ethnography to the Critical Realism Network, names this as a common issue with grounded theory. She asserts that one of the many challenges of grounded theory approach is “that there is no mechanism for adjudicating between different theoretical frames.” She goes on to ask the apt question - “How do we know which theoretical category to employ and which is more accurate at describing the situation at hand?” (Decoteau, 2017).

The time-consumingness of my struggle to situate myself within the complex methodological landscape of critical, interpretive research often led to ‘compulsive questioning,’” which Chaudry describes of her experience with critical research and ethnography, as well (Pillow, 2003). Without an experienced critical scholar or ethnographer to guide me each step of the way, this compulsive questioning tempted me to abandon the project of trying to know altogether. Chaundhry reports a similar experience – she “g[a]ve up looking at the transcripts” (Pillow, 2003, p. 190).

In the end, I stayed true to my research process and continued with critical ethnography. I have been guided by my overarching research questions, and a combination of theory, critical questioning, reflexivity, and close examination of the

data, allowing the story to unfold and writing what emerges to me. Given the space and the remit to critically reflect on my research process has allowed me to proceed with renewed confidence that I am doing meaningful research, despite resistances I experienced and likely will continue to encounter.

This critical reflection is a part of my story of attempting and struggling to do critical scholarship within the context of engineering higher education. It's not a critique of my advisors, it's a critique of the system in which we are all bound. Few aspects of our academic life seem geared toward creating the conditions for robust and thoughtful critical scholarship. Doing qualitative, critical scholarship in a field like EER, which is dominated by positivism, is that much more challenging.

I tell this story, as well, to provide an illustration of what resistance and the outcomes of resistance in this context might look and feel like. That my supervisors ultimately gave me that time and space to sit with the struggle, to resist their requests for "more data" or a clear problem statement, and to explore these methodological tensions with me, has been incredibly meaningful. It was the inspiration for this critical reflection and was essential to being able to deepen my critical practice. It was hard work, but in the long run, I felt like I've had a chance to really learn. In fact, my time as a doctoral student has been one of the most rewarding educational experiences I've ever had.

Even more powerfully, however, is that my struggle fostered an ongoing dialogue between me and my supervisors that has rippled out throughout our university. When I started, these conversations were on a one-to-one basis. Today, my current engineering supervisor has successfully carved out a home within the engineering department, where we are doing critical research, advancing curricular changes, and working to infuse a critical and engaged pedagogy with other academics. We are connecting and collaborating with scholars from other disciplines, including management and geography to advance our work. There is a great deal more work to be done, but by sharing this reflection, I hope I have provided some insight into how we can advance our resistance of the status quo and strengthen our critical scholarly practice within engineering education research.

The remainder of this thesis expands on the theoretical frameworks, methods, and findings of my critical ethnographic work.

Chapter 3 – Theory and Methods

Theoretical frameworks

Critical Realist Ontology

I can't help but wonder, through all of this and the many conversations I've had, do I need establish myself as a critical and/or feminist scholar, in order to explore more deeply the power dynamics entrenched in the process of developing a course such as this? And then pursuing "sustainable development" in developing settings from a British institution? (reflection, June 26, 2018)

These were the types of questions I was asking myself about the intersection of methodology, my positioning within an engineering department, and theory throughout much of my doctoral research. These questions ultimately led me to critical realism. Though I came to critical realism late, it helped provide a framework through which I could better understand my methodological journey and analytical position. Shifting away from grounded theory toward a methodology that allowed me to incorporate my subjectivities required a stronger definition of my ontology and epistemology, or my assumptions about the nature of social reality and how we can come to know anything about that reality. If, in rejecting grounded theory, I was rejecting the assumption that social knowledge could be created separately from the researcher, then I needed an articulation of the relationship between researcher and researched that allowed for the relational aspect of knowledge creation. I needed a framework that acknowledged the relationship between our subjectivities and the very real conditions that informed and shaped them over time. I also needed a framework that allowed for the fact that any story I told was only partial. The social ontology of critical realism provided this comprehensive framework.

Critical realism is an ontological meta-theory that forms the connective tissue between context, methodology and analysis within this thesis. Originally proposed by Roy Bhaskar as a philosophy of science (Bhaskar, 1979), it has also been applied within social theory and cultivated into a comprehensive social ontology.

Critical realism advocates a stratified view of social reality: the real, the empirical and the actual. This stratification allows us to acknowledge that our

knowledge about the world is only ever a partiality. This does not mean, however, that the world does not have truths and causality, it just acknowledges that we may not be able to fully observe, explain or know them. Critical realism “acknowledges that the world is real, and that knowledge production is fallible and theory-dependent, but not theory determined” (M. Archer, 1998). In sum, a critical realist ontology acknowledges that there is a reality, though we, as human beings, may not be able to elucidate it entirely. It exists “independently of our perceptions and constructions” (Maxwell, 2018, p. 19).

This definition allows for human beings to define and re-define knowledge as we learn more about the world, but acknowledges our understanding is inherently shaped by what we already know (hence, the relational aspect of knowledge building). But our social reality is an open system, which allows for new ideas to be generated. “To the realist, the one factor which guarantees social systems remain open...is that they are necessarily peopled. Since realism insists upon a stratified view of the social, like any other reality, then there are properties and powers particular to people which include a reflexivity towards and creativity about any social context which they confront” (Archer, 1998, p. 190).

Critical Theory

Critical theory originated in the early 1900s, emerging out of the Frankfurt School, a unique research project within the University of Frankfurt, Germany. The School accommodated a diverse group of social scientists, including Habermas, Marcuse, Adorno and Horkheimer, with backgrounds including psychoanalysis, sociology, philosophy and economics. The driving force behind the work of the Frankfurt School was to develop social theory that was “philosophically informed and of practical political significance” (Alvesson & Sköldberg, 2017, p. 181). An explicitly political stance was a key defining feature of their work. Critical theorists took aim at traditional science as exercised through positivism, in particular the researcher’s role as a neutral, objective observer, “who follows specified methodological rules for acquiring knowledge about limited and testable causalities” (Alvesson & Sköldberg, 2017, p. 181). To the Frankfurt School, positivism represented an unquestioning acceptance of society and its institutions as they were. Instead, the role of critical theory was, and still is, to question taken-for-granted assumptions about the nature of

social phenomena, and our understanding of ourselves as social actors within those phenomena. The ultimate goal of this work is emancipation and enlightenment, to free ourselves from the constraints of society as it is, and to surface insights and imaginaries about what it could be (Geuss, 1981).

Original Frankfurt School critical scholarship has evolved, particularly in response to critique that it is too theoretically driven and divorced from empirical research. It has fractured into a variety of areas of social theorising and empirical inquiry. I draw on the following positions, where some consensus lies in the role of critical inquiry:

- “Seeking to expose, oppose and redress forms of oppression, inequality, and injustice” (Charmaz, 2017, p. 35)
- “Acknowledging that societal conditions are historically created and heavily influenced by asymmetries of power and special interests” (Alvesson & Sköldberg, 2017, p. 180)
- Acknowledging the role of human rationality and capability as a powerful agentic force that can, to some extent, transcend coercion and constriction imposed by structural power.

Critical theory is underpinned by several important concepts, which I summarize below.

Structure/Agency

Critical social research relies on some conceptualisation of “structure” and “agency” as forms of social institutions and/or processes. Much social theorising has been dedicated to fully conceptualising the nature and mechanisms of social structures, and how individuals within society (agents) interact with, are shaped by and shape structures.

Giddens’ structuration theory has strongly influenced current conceptualisations of structure and agency; in particular, how we understand the “meeting points and processes of interaction between structure and agency” (Stones, 2009, p. 89). Giddens theorizes the *dual nature* of structures as a medium *and* an outcome of action (by agents). A structure is an extension of the actor - actors interact together within a system (society’s major institutions) that have boundaries and rules but has space for them to formulate and reformulate that system. Structured

activities can be arranged in terms of “rules” and “resources,” and behaviours are “patterned in” and “out” depending on utility to the system/society. “Agents’ action and interaction are constrained by, yet generative of, the structural dimension of social reality” (Giddens, 1987, p. 8). In sum, according to structuration theory, structuration = actors’ interactions with systems; system = society’s major institutions; structure = acts as a guard for the perpetuation of society; agents = actors that form and re-form structures (Giddens, 1987, 2012).

However, Giddens’ structuration theory has been criticized for being difficult to use for empirical research. Archer offers an antidote to this through the critical realist interpretation of structure and agency and the relationship between them. She agrees with Giddens, to a certain extent, that structure and agency are mutually generative; however, she suggests it is important to separate them for analytic purposes, which allows for the examination of the “interplay between them” (Archer, 1998, p. 203).

Another point of departure between structuration theory and critical realism lies around the temporality of structures. Archer argues that structuration theory focuses the temporality of structures within the present by making them *activity-dependent*. Instead, critical realism asserts that structures are historically contingent, generated *across* temporality (M. Archer, 1998).

Power

A key assumption within critical social theory is that *power* is a key mechanism through which society is produced. Doing critical research means we cannot study or analyse our society without acknowledging the multiple possible roles that power plays in the social scenarios that we study.

However, the nature and the mechanisms of how power work through society are highly contested. Lukes (1974) considers power to be “essentially contested,” or a contested matter that cannot be settled empirically. Clegg and Haugaard (2009) argue that our understanding of power is more like what Wittgenstein calls a “family resemblance” concept, or a cluster of overlapping concepts that share overlapping characteristics, but “do not share a single essence” (p. 4).

One debate over the nature of how power works in and on society is whether it is a social construct. Power may not be entirely socially constructed. There are many examples throughout the natural world where power exerted by one being over another can be seen. While at some fundamental level, the game of power that ensues through the scramble of dominance and control over scarce resources, may, in some way be driven by innate and deeply rooted structures of our brain, the way that power exerts itself amongst human beings is most often socially constructed. Take race, for example. It is only in the last 400-500 years that human beings have decided on artificial characterizations of otherness, based on skin colour, and called them “races.” Then we have used notions of race to establish dominance and control of one group over another.

Another debate about power coalesces around its mechanisms. Some philosophers have argued that power is enacted by individual agents. Hobbes suggests that power is exercised through domination of individuals over one another. The likes of Arendt, Parsons and Barnes developed a view of power driven by individuals as consensual, opposed to the view of power as the exercising of coercion and violence. Their conceptualisation amounts to power enacted through individual agents as the *capacity for actions*, or “power to” (Clegg & Haugaard, 2009; Parsons, 1963).

Others theorize that power is systemic. Nietzsche’s “will to power doctrine” includes the proposal that humans (and potentially all life) are driven by the “enhancement” of our power, and this drive is good for us (Anderson, 2022). Foucault is known for driving our understanding of social power as something constitutive of social reality, and not attributable to individuals, *per se*.

Dowding, Giddens and Haugaard have become known for merging the idea of power as an agency-based *and* systematic phenomenon. This synthesis view of power has become increasingly accepted throughout social theory and research (Clegg & Haugaard, 2009).

Critical pedagogy

Critical pedagogy, as its name suggests, is a critical project focused on education. Critical pedagogy is more than theory – it is a framework for “moral and political

practice.” It assumes “education is fundamental to democracy,” and for democracy to function, a pedagogy that produces “citizens who are critical, self-reflective, knowledgeable, and willing to make moral judgments and act in a socially responsible way” is necessary. Critical pedagogy “provides tools to unsettle commonsense assumptions, theorize matters of self and social agency and engage the ever-changing demands and promises of a democratic polity” (Giroux, 2011, p. 3).

Paolo Freire’s seminal work, *Pedagogy of the Oppressed*, was foundational to critical pedagogy. According to Freire, a typical student-teacher relationship has a “narrative” character. The role of the teacher is to “fill the students with the contents of [their] narration.” This content, Freire argues, is detached from the world, devoid of context and therefore, deeper meaning. By teaching content that is disconnected from its context, students are filled with words that are “emptied of their concreteness,” which “become a hollow, alienated and alienating verbosity” (Freire, 1970, p. 71). In this way, he suggests that “education becomes an act of depositing, in which the students are the depositories and the teacher is the depositor.” This is the basis of what Freire calls the “banking model” of education. The banking model occurs through the following “attitudes and practices:”

1. “The teacher teaches and the students are taught.
2. The teacher knows everything and the students know nothing.
3. The teacher thinks and the students are thought about.
4. The teacher talks and the students listen – meekly.
5. The teacher disciplines and the students are disciplined.
6. The teacher chooses and enforces [their] choice, and the students comply.
7. The teacher acts and the students have the illusion of acting (who were not consulted) adapt to it.
8. The teacher confuses the authority of knowledge with his own professional authority, which he sets in opposition to the freedom of students.
9. The teacher is the subject of the learning process, while the pupils are mere objects” (Freire, 1970, p. 73).

The practice of critical pedagogy is an active resistance against the banking model and the cultural forces that produce this instrumental education form. Foundational to this resistance involves the acknowledgment there are many ways of

knowing, including “the corporeal and the emotional” and that “knowledge is always a site of contestation and conflict” (Kincheloe, 2008, p. 10). The inherent capability for human beings to utilise their rational minds to wrestle with various perspectives and ways of knowing, to resist oppressive forces in society, makes the structure/agency paradigm central to critical pedagogy.

Anti-colonialism

Another set of critical frameworks that I draw from in this thesis are postcolonial or anti-colonial theories. Anti-colonialism is a theoretically-ground, political position that in order to undo the impacts of colonisation, we must engage in praxis. We must interrogate our positionality, developing awareness of how we might reproduce colonial power relations. But this work needs to go beyond individual thought and behaviour change – it must be committed to action, to working to undo or re-structure these conditions.

I use the term colonial or neo-colonial, rather than post-colonial, to ground my arguments around the position that colonisation has never really ended. The process of colonisation was insidious; a totalising takeover of the material, human and cognitive resources of entire peoples, leading, in many cases, to erasure of traditional customs, ways of being, thinking and doing. During the colonial period, the structural, discursive, and epistemic positions of racialised, imperialistic capitalism grew and solidified. Postcolonial “does not suggest that the values and practices that were inherent during the colonial era are now gone. Nor does a postcolonial lens define a radical new historical era, where the ills of the past have been cured” (Boisselle, 2016, p. 3). Using “neo-colonial” or “colonial” rather than “post-colonial” recognizes this temporality.

I also use the term “coloniality” to describe the “long-standing patterns of power that emerged as a result of colonialism...that define culture, labor, intersubjective relations, and knowledge production well beyond the strict limits of colonial administration” (Maldonado-Torres, 2007, p. 243). Maldonado-Torres (2007) contends that coloniality is “maintained alive...in the criteria for academic performance, in cultural patterns, in common sense, in the self-image of peoples, in

aspirations of self, and so many other aspects of our modern experience. In a way, as modern subjects we breath coloniality all the time and everyday” (p. 243).

Colonisation was not only a totalising force on the colonised, but it was also a totalizing force on the “metropolises.” Metropolitan higher education institutions (HEIs) have not been immune to these forces; indeed, they have perpetuated colonial discourses and practices. Education is a place where particular ideologies and cultural patterns are taught and reinforced or can be questioned and reformed. Incoming students enter higher education with the expectation that they will be “introduced to the norms, beliefs and ways of understanding the world” (Cech, 2013, p. 4) common within their area of study or professional socialization.

As discussed in the Introductory chapter of this thesis, engineers have had an outsized role to play in the instantiation of colonizing power relations. Therefore, examining the ways that engineers may continue to participate and perpetuate colonial power relations through their formation within western HEIs is critical to a decolonising project.

Decolonising approaches to education are largely focused on the task of forming or re-forming curricula and pedagogies that acknowledge, appreciate, and embed other ways of knowing, being and seeing the world.

In later chapters of this thesis (5-6), I will explore the ways in which colonial practices, discourses and institutions existed within the spoken and contextual fabric of the SEM4ID course. I aim to “look at social forms as produced by historical practices combining knowledge and power” and “seek to examine how truth claims are related to practices and symbols that produce and regulate social life” (Escobar, 2011, p. 12).

Methods

Escobar argues that “we need to anthropologize the West” (Rabinow 1986, as cited in Escobar, 2011, p. 11). This thesis aims to contribute to that project. The empirical contributions of this thesis are drawn from an ethnographic study of an engineering department within a British HEI, with field work taking place in 2018-2019. My

analysis was informed by the theoretical frameworks outlined above, alongside my methodological journey and positionality, illustrated in Chapter 2.

My primary data collection methods involved participant observation, ethnographic and semi-structured interviewing, and journaling. Though participant observation is often considered the primary data collection strategy of ethnography, I did semi-structured interviews with participants to dive deeper into areas of emerging interest, to establish details of events and scenarios within the case, and to get to know participants better. Hockey and Forsey (2012) assert that the interview is a way of knowing what otherwise would be unknowable by observation alone. Interviews bring to the fore more details of what otherwise would be left to the sub-conscious or at the very least, the privacy of an individual's mind (Hockey & Forsey, 2012; Skinner, 2014). In addition, I collected student critical reflection submissions to give deeper insights about the type of work students were producing, along with university documents to provide institutional context.

I used journaling as a tool throughout to capture and explore my thoughts, feelings, and to critically reflect on my position to the research, as well as help me to navigate decision making throughout my work. I often used the critical incident technique to help me surface and interrogate challenges that arose throughout the research process. Originally developed to foster learning in professional settings, the critical incident technique consists of a broad set of principles to help identify and articulate dimensions of behaviour that are most important to the setting in which it is being applied (Flanagan, 1954). Since its development, it has been adapted across a vast number of fields, from aviation to social work (Flanagan, 1954; Fook & Gardner, 2007). The technique has also been adapted to the practice of critical reflection, as a tool to catalyse critically reflective thinking (Fook & Gardner, 2007). In the context of critically reflective practice, a critical incident is simply an incident that is significant to the individual and is one that inspires learning. In my experience, critical incidences arose through psychological discomfort, feelings that, once recognized, motivated me to articulate my experiences to myself and work to learn from them. That critical incidences arise from negative experiences or emotions appears to be a wider phenomenon, as reported elsewhere (Fook & Gardner, 2007).

I used these various tools to first, develop an overall picture of what was happening in the College of Engineering at Swansea University, particularly in relation to the new MSc courses that Andrew developed. I was also working to identify what was happening within the courses that was theoretically interesting – i.e. were there any teaching methods that seemed particularly effective, new, interesting; or were there any assignments that were innovative or provoking surprising responses from staff and/or students.

In order to get data to satisfy these interests, I:

- Obtained a focused and dense record of student experiences during their field work for the SEM4ID course (method: intensive observations recorded thickly, unstructured/ethnographic interviews with students)
- Obtained a less focused and less dense record of the context in which students were doing their field work (method: observations recorded thickly, casual conversation with community partners)
- Obtained a record of student, faculty and department leadership interactions (method: observations)
- Produced a record of the process and mechanisms by which these new courses arose and how they were implemented (method: interviews with faculty, observation during relevant meetings)
- Obtained and analysed student assignments through thematic analysis

Key informants/participants involved staff and students involved with SEM4ID, in the 2017-2018 and 2018-2019 cohorts, as well as community partners in Sierra Leone and Zambia. All key participants gave their informed consent.

In the early days of data collection, I focused on the following “low level theoretical concepts”/categories of interest, including, but not limited to:

- SU College of Engineering
- UK/Wales context
- Faculty involved in SEM4ID
- Students involved in SEM4ID
- Modules, curriculum

- From early conversations with Andrew:
 - Global engineer
 - Sustainability/sustainable development
 - Creative, entrepreneurial engineer
- Organizational change/development - institutional barriers to change

Participant observation occurred at multiple sites. I attended various large and small group meetings with SEM4ID students and staff at Swansea University. I also sat in on and provided guest lectures within taught modules. I travelled to field sites with students and observed them in action as they carried out field research and project implementation. In Sierra Leone, that included walks around different areas of Home Leone's Destiny Village, minibus journeys to "slum" areas of Freetown, and various errands to markets, stores, scrap yards, and workshops. In Zambia, I travelled by bus with students and staff up to the northern Copperbelt Province, and then south to Siavonga. I worked alongside them on construction projects at the Mutende Children's Village in the north and observed their meetings with community stakeholders and school staff at the Siavonga Primary School in the south. In the north, I joined SEM4ID students when they travelled to nearby towns to carry out their research projects.

While I was in the field in Sierra Leone and Zambia, I worked a flexible observation schedule, which relied primarily on the schedules of the SEM4ID students. I used what (Carspecken, 2013) calls "the method of priority observation," which for me, involved focusing on 1-2 students at a time to focus my "thick description" and fieldnotes. This worked well in Sierra Leone, since each student was working on their own distinct project, and I could focus my observations on each of them, individually. In Zambia, this broke down a bit at times, for several reasons. First, students came at different intervals – giving me more time with half of the team and significantly less with the other half. Second, some students were fastidiously organized in their approach to data collection - they had meetings organized in advance of the trip and followed a structured schedule most days. This made close observation of student work and progress relatively straightforward. Other students, however, had less structure and organisation to their projects for a

variety of reasons, but it made the focus of observation less clear. Because of this, I noticed my attention more heavily focused on the students' work that was more structured.

In some larger group meetings, I attempted to describe the scenarios holistically, rather than focus on one student or another. In hindsight, it might have been more useful to continue the priority observation of one person or another, depending on their role in the meeting and what information I was hoping to record. However, it did give me a view into group and team dynamics. I got to better understand how the individuals I had observed on a 1-2-1 basis operated in teams. From their group discussions, I also learned of many complex challenges of navigating multi-stakeholder relationships in the context of their ISL projects.

Gaining informed consent

The formulation of the research project occurred through interaction with staff and students who would ultimately become participants in my proposed study. They were aware of my intention to study engineering in higher education context, and my interest in the SEM4ID course.

I applied for human subjects' research approval in April 2018, with the intention to begin the study in May 2018. The project proposed to follow SEM4ID students through their learning experience, to understand what it is like for them to learn and integrate inter-disciplinary methodologies into their scholarship and practice and to better understand what type of practitioners these students become. Ultimately, this study aimed to dissect this new style of applied learning, to understand if it can prepare engineering graduates to be transformational leaders. After a request for minor amendments to my application, I was granted approval from the ethics committee of the CoE on May 26, 2018.

I used an informed consent process to engage "participants" in the study. Participants had an opportunity to read and overview of the study, before filling out an informed consent form. I told each participant that they were free *not* to participate and offered to answer any questions they had about the study.

I gave participants the option to have their real names included in the project, or to remain anonymous. The majority of participants chose to allow their first names to be used. Fewer chose for only their initials to be used, and fewer still chose to remain anonymous.

Despite having consent from many to use their real names, I struggled with whether or not to develop pseudonyms. I knew that pseudonyms were an important ethical standard; they help maintain the confidentiality and privacy of participants long after the research is complete. However, deciding on a pseudonym for people I knew and had formed close collegial relationships with felt daunting, like a whole project in and of itself. Not just to identify them, but to transpose the meaning, memories and relationships I had built with very real people who I knew by one particular name, onto a fictional name. Would this blur lines between fact and fiction as I narrated our story?

Weiss and McGranahan explore some of the practical and ethical concerns that ethnographers face when considering naming or pseudonym-ing their participants, colleagues or co-conspirators (Weiss & McGranahan, 2021). McGranahan contends that there has been a shift in ethnography from “excluding individuals in our texts” to “including ‘named individuals and characters’” (McGranahan, 2021, para. 3). “This shift marks changes in our analytical valuing of actual people in our research rather than only the knowledge they share” (para. 3). The practice of naming individuals with pseudonyms persists as standard practice. However, McGranahan argues that though it is contentious, there is value in questioning the standard practice (McGranahan, 2021).

In the end, I decided to create a pseudonym for my participants/key informants. Given the critical nature of this work, I felt it was important to provide participants with confidentiality when discussing difficult or potentially controversial topics.

Analytical Strategies

My work in transforming what started as a conventional ethnographic project, as discussed in Chapter 2, into a critical ethnographic project largely took place as I transitioned out of the field and into analysis and writing. Critical ethnography

offered a path forward in helping me to make decisions about where to turn my attention during data analysis. It offered answers to how to manage the difficult questions I had started asking and the more active role I was taking as a participant/observer as part of the research process. Critical ethnography also helped resolved some of the ontological, epistemological, and ethical tensions I felt navigating between inductive grounded theory and my lived experience doing field work. As Thomas (1993) describes, “critical ethnography refers to the reflective process of choosing between conceptual alternatives and making value-laden judgments of meaning and method to challenge research, policy, and other forms of human activity” (p. 4). A critical approach to ethnography acknowledges the political implications and emancipatory possibilities of studying culture sharing groups (Thomas, 1993). It does not attempt to be “neutral” and demands an ethic of responsibility to address institutions of injustice. It shifts the aim of studying social processes from description of “what is” to “*why* this is” and “what could be” (Decoteau, 2017).

In practice, this process began as I combined my records, including meeting and interview transcriptions, thick and thin description, and my reflective journal entries, into books of fieldnotes. Developing fieldnotes are a core practice in ethnography. However, each ethnographer develops them differently. According to interviews with a number of experienced ethnographers, cultivating fieldnotes is a very personal process, and is based on personal preference, personality, purpose of and situation they are in when doing their research (Walford, 2009).

In my case, combining my records was part of my analytical process, to begin to build a picture of *what was happening here*. It allowed me to start to see what felt like fragments of information about the social scenario as a more cohesive story, told over place and time. It was a creative and non-linear process, and critical reflexivity was a key strategy throughout.

Critical Reflexivity

Pillow suggests that there are four common ways that reflexivity is used in qualitative research: Reflexivity as recognition of self/“researcher know thyself”; Reflexivity as recognition of other; Reflexivity as truth; and Reflexivity as

transcendence. However, these approaches rely on a subject that is “singular, knowable, and fixable” (Pillow, 2003, p. 180).

Critical reflexivity, on the other hand, is rooted within the goals of the critical scholarly tradition. It demands that social phenomena are viewed within a historical and political context. The researcher therefore works to unveil the unexplored, and often implicit “taken-for-granted” that may contribute toward reproduction of unjust structures of power.

In its postmodern form, reflexivity aims to “account for multiplicity without making it singular” (Pillow, 2003, p. 181). It places values reporting on the various complex and context-dependent mechanisms by which knowledge is produced vis-à-vis the researcher and subject (or knowledge producer) (Alvesson & Sköldbberg, 2017). A critically reflexive researcher recognises there is no single objective way of knowing, therefore, values multiple epistemologies and theoretical possibilities to inform interpretations of meaning.

Critical reflexivity is therefore a multi-dimensional form of reflexivity, whereby the researcher creatively, yet systematically, reflects on data alongside theory. It involves systematic interpretation of potential underlying meanings; critical interpretation of ideology, power and social reproduction; and reflection on text production and language use with regard to our own textual development, claims to authority and selectivity of voices that we chose to represent in our text (Alvesson & Sköldbberg, 2017). Though systematic, the aim is to stay “light of foot” – not becoming bound to one theoretical position or another, but relying on the researchers’ best judgement, intuition, and ability to see and point out what they believe is important. “The trick, then, is to control theories (interpretive possibilities), without letting them control you” (Alvesson & Sköldbberg, 2017, p. 274). This style of interpretation recognizes and allows for our innate human capacity to reflect and interpret at multiple levels.

Hermeneutics

Key to reflexive analytical work involves hermeneutics; a process of interpretation of textual data, with fundamental assumptions of the origins of our interpretive lens, or how our understanding of the world comes about. The “circle” is often used as a

metaphor for the hermeneutical interpretation process, emphasizing how understanding is “relational and referential; we understand something by connecting it with something we already know.” The hermeneutic circle is not fixed, like a clock, with “mutually exclusive points around a rigid circumference, which make it impossible, say, for it to be both 3pm and 8pm simultaneously.” Rather, it is “an expansive and productive way of thinking about the constitutive relationships between things, steering us away from abstract, ‘either/or’ thinking which strips human phenomena of contextual richness. The more circular our movements in interpretation, the larger the circle will become, embracing more contexts, more perspectives, and more possibilities of understanding.” There is no one way the hermeneutic circle is applied - “different theorist work with circles to emphasize their own particular interests and concerns” (Tomkins & Eatough, 2018, p. 3).

Becoming clear on who I am and what I bring to the process of interpretation has been central to decision making in how I go about interpreting text, including the types of boundaries and fail safes I need to create for myself in order to prevent getting stuck and only viewing data from one perspective or another. As Tomkins and Eatough describe, making the context within which a text is produced explicit is integral to the process of understanding, from the perspective of the researcher and the audience who read that interpretation. Context refers to “the whole context - culture, customs, discourse, conventions, and personal circumstances, etc - from which the author of the text is writing” (Tomkins & Eatough, 2018, p. 4).

In practice, reflexivity often reminded me of the experience and art of film photography. Capturing an image using a camera can involve multiple processes, including focusing the camera lens, and changing the aperture or shutter speed to see different depths of field of an image. I might be standing in the same place every day, but each day, I zoom in or out slightly, refocus the lens, change the depth of field, and end up seeing different details, and capturing slightly different images of the same view.

I spent stretches of time focusing on my data, zooming in and out on different aspects of it, trying to make sense of what I was seeing. Then I would step back from my data and re-focus myself on reading the literature. After a particularly long stretch away from my data, I decided to re-approach the whole of my data set and

compile it into a primary record of my time in the “field,” i.e., during an extended period when I took fieldnotes, conducted interviews and did participant observation and reflection on my experience embedded within the social scenario. Because it has been some time since I had read through my data, I decided to read through it in its entirety, a process called familiarisation (Ritchie & Lewis, 2003). I did an “intensive reading” of the text, where I took care to read line-by-line, and began to jot down low inference codes (G. R. Gibbs, 2018). This approach is advocated, particularly in grounded theory, in order to stay close to the data while developing theory. These codes are both data driven and concept driven - they came both from an *a priori* understanding of the literature and what may be emerging from my data that connects to it, and an inductive, interpretive approach, allowing potential new theoretical or conceptual ideas arise from the data (G. R. Gibbs, 2018). Gibbs (2018) offers a set of categories that can be used to guide the coding process, such as specific acts or behaviours, practices, states of being, and meanings, and I referenced this throughout my initial intensive reading to help me expand my thinking about what I might see in the text upon future readings, to ensure I was not missing anything critical. In addition to low level codes that emerged, I noted any emotional reactions to what I read, any questions I had about meaning, as well as reflections about my role as researcher, particularly in response to my reflexive notes within the text.

This familiarization and line by line approach was slow, and I think because of this, my approach to coding evolved throughout. Each time I sat down at my data, I saw new aspects of it, I understood it in new ways, and I interpreted what I saw slightly differently. This came out in the way I coded. Some days, my coding was sparser and simpler. I coded broad categories of what I think I saw. Some days, I coded based what I believed to be the underlying meaning of what I believed was happening. Sometimes I coded based on *how* something was said, sometimes I coded based on *what* was being said (categorically). Some days, I coded my immediate reactions to what I saw, how what I read made me feel or what it made me think of. Often my initial reactions had a critical spirit - I had trained myself to see systems and structures encoded within text. Yet, I was also aware that some of these interpretations may have been surface level judgments, and that I needed to dig deeper as I moved further into my analysis. Some days, I was better at taking a step

back from my initial reaction to the data and was able to characterize what I was seeing from more of a distance, or at least I was able to ask myself questions about what I thought I was seeing, rather than move to immediate judgment.

Upon reflection, I believe this careful familiarization process helped me deepen my critically reflexive approach. It forced me to look very closely at the data, before I “zoomed out” to see a bigger picture. As in photography, where it is impossible to know what you have captured until a photo is developed and printed on a page, the final conclusions of this reflexive project will likely not be “developed” and crystallized until this thesis is printed.

The remaining chapters of this thesis are a result of my attempts to “develop” some “photographs,” i.e., taking snapshots of my data and putting them through multiple analytical processes of development. Each attempt has taken a slightly different form; therefore, I specify any variations to my methodological process in each chapter.

Chapter 4 – Boundary Pushing Education

Introduction

In the following chapter, I provide a descriptive account of various teaching and learning practices within SEM4ID. As was alluded to in Chapter 1, SEM4ID pushed the boundaries of traditional engineering education in a variety of ways. In this chapter, I document the various ways that SEM4ID subverted tradition, from my own perspective, developed through participant observation. Using reflexive analysis, I draw connections between SEM4ID and two emergent practices in engineering education: *critical pedagogy* and *interdisciplinarity*. For each of these emergent practices, I identify the various ways that SEM4ID aligned with the core principles, objectives, and various approaches within those practices. I then go on to acknowledge the ways in which SEM4ID may have fell short in resisting tradition: where it pushed up against and was unable to overcome structural barriers, and the ways in which the limitations of knowledge, experience, and the resource of time limited the force and effectiveness of resistance.

Critical pedagogy

From my early entry into fieldwork, I observed students and staff involved with SEM4ID were highly engaged in collaborative learning. Students and staff working closely together, grappling with new and challenging taught content, as well as experimenting with non-traditional pedagogy, created a space for teachers and students to challenge the “banking model” of education in many ways. This struck me as the beginnings of a critical pedagogy, playing out in practice. In the following sections, I provide a series of vignettes from SEM4ID that evidence some of the practices and attitude that helped to upend normative student-teacher relations. These practices, including the cultivation of *staff-student partnerships*, the enablement of *student autonomy*, and embrace of SEM4ID as *a learning space*, helped break down the dehumanizing effects of the banking model of education, and resulted in critical thinking and heightened critical consciousness amongst students and educators alike.

Student-Staff Partnership

My entry into the field began halfway through the first year the SEM4ID programme was run, and I felt like I had stepped on board a moving train. It was clear that there was *something* interesting happening.

The course had a draw, a certain magnetism that seemed to inspire dedication and hard work. There was a high level of staff and student engagement. I suspected there were several reasons for this high level of engagement. It might have been due to the *mission* of the programme – rarely, if ever, had these staff or students had the opportunity to do “good” while doing engineering. Andrew, who had catalysed the programme, spoke publicly about his inspiration to start SEM4ID came from having his daughters, and wanting to make the world a better place for them. It may have also been due to the *high stakes*. Students were working with “real projects, with real stakeholders, real engagement and real money involved” (interview, March 27, 2018). The high level of engagement may have been due to the *novelty* of the course. No one, students or staff, had been involved in an educational program that combined experiential, problem-based learning (PBL) through international service learning (ISL) and multi-disciplinary course work. The programme was fast-paced and challenging, both inside and outside of the classroom. There was almost a start-up type of energy surrounding the course. It seemed like there was a strong desire amongst the group to continuously improve the course, so that it would be a meaningful and useful learning experience that year, but also for years to come.

One of the first times I interacted with the whole group was at a meeting between Andrew and Victoria, who were teaching and coordinating SEM4ID, the students, and the Head of College (HoC). By this point in the academic year, students had formed into their project teams and had already gone into the field for their scoping trips. The meeting largely focused on a discussion of how the course was going; teaching staff present on the course elicited suggestions for how it might be changed. I was interested to see that the students were not quiet and did not hesitate to provide their feedback about what was and was not working about the course.

That day, discussion revolved around the module order, content, assessments, and student field work. After returning from their scoping trips, students had gained insight about which modules were most useful for their field work, and what they

were missing. For instance, students seemed to agree that their monitoring and evaluation module should have come before the scoping trip (it came after).

They discussed feedback mechanisms, those that were working and where they needed more support. For example, they highlighted that it had been helpful to get feedback about their progress on their critical reflection assessments in advance of the deadline. Getting feedback was helpful for them to understand where their work should go. The engineering students, in particular, admitted in different ways that they struggled with this particular assessment. They were not used to writing projects like this, so it took them time to understand how to orient themselves and produce this style of work. Overall, however, students reported that beyond this one assessment, they felt that they needed more written feedback.

The conversation continued and covered the nature and structure of the final dissertation. Then it turned to issues students were having in navigating relationships between the many stakeholders in their projects. They were struggling with the lack of clarity around the parameters of authority and power for the projects. One student mentioned it was difficult for them to find balance between delivering “value” in the field on a technical project, versus developing as individuals and as students.

This early encounter was formative. It surfaced a number of themes and dynamics that persisted throughout my time embedded in the social scenario. I was struck by the high level of engagement of students in their own learning, and the high degree of transparency and openness to feedback amongst staff. Lecturers and students were troubleshooting issues about the course together and making adjustments in real time. Students seemed comfortable providing critical and constructive feedback, and staff were willing to listen and learn from the students’ experiences and opinions. Students seemed like they had been thinking critically about their education – they had opinions and were engaging in discussion about their learning. And they were granted a high degree of trust and autonomy to direct their projects and engage with community-based stakeholders. This did not come without risks. However, it did not seem to derail the high level of trust, openness and cooperation between staff and students that had been established before my encounter. I would come to find out that this style of engagement was a regular occurrence, and I would end up sitting in on many more in the months ahead.

These staff-student dynamics carried many of the elements of student-staff partnership. Student partnership is a growing movement within higher education due to its promise of challenging the “student-as-consumer” model, where students are passive recipients of their education (Cook-Sather et al., 2014). When students and staff partner to co-create educational experiences, students “shift from being passive recipients or consumers to being active agents.” In doing so, students also “shift from merely completing learning tasks to developing a meta-cognitive awareness about what is being learned” (Bovill et al., 2016). Partnering with students to co-create components of the curriculum and/or pedagogical approaches has been shown to enhance “engagement, motivation and learning;” “meta-cognitive awareness and a stronger sense of identity;” “teaching and classroom experiences;” and “student-staff relationships and development of a range of graduate attributes” (Bovill et al., 2016, p. 196).

Bovill and her colleagues developed a typology of common student roles when students and staff are involved in co-creation of learning and teaching. The four roles identified include: *consultant*, sharing “valuable perspectives” on the educational experience; *co-researcher*, involving collaboration on educational or other subject-based research; *pedagogical co-designer*, co-constructing the curriculum and pedagogical strategies, and *representative*, making contributions to a variety of decisions in the higher education context (Bovill et al., 2016).

Within SEM4ID, students appeared to take on three of the four student roles within this typology: in particular, the pedagogical co-designer, consultant, and representative roles. During another meeting where staff and students had gathered to discuss preparations for the final dissertation and project implementation, students stepped into all three roles at various moments. For instance, they were consultants when questions about the marking system were raised.

Chris: Um, I have a question about the weighting, about the marks.
(Victoria: Yeah?). You know how that works? Because, just wondering about how our marks, yeah –

Victoria: Yep, so, dissertation, technical dissertation, socio-technical dissertation is 30%. Which means -

Chris: Yeah, I mean, like, from all the modules from before.

Victoria: This is 60 credits. This is 1/3 of your masters.

Alyssa: But it's it double weighted, isn't it. (**Victoria:** Is it?) So, I think so. It is 60 credits, but those 60 credits are double weighted, so.

Victoria: Do you know? I thought it was...

Chris: Yeah, that's what I'm asking.

Alyssa: And also, like, if you want a distinction, (**Chris:** Yeah) you have to average 70 percent, but you also have to get 70 in your dissertation. But it doesn't matt- like, so if you got 65-

Andrew: I have to discuss this with the quality office, cause we-because of the way we're formatting our-

Alyssa: This is what all of it's like- If you just type it into Google, like- Swansea has a whole page of (**Chris:** Ok so you're just going by that, you're not doing it-) how it works. But I don't know whether you'll change it.

Victoria: But also, the College is different, so

Cristina: That's why I said –

Andrew: Yeah, I wasn't aware there was a weighting. I just discussed this the other day within the College. I just thought it was just a strict average.

Luke: I think it used- for engineering it used-

Victoria: Is there a phone here? I might just call [an administrator] real quick.

Andrew even acknowledged a mistake he had made in allocating marks.

Victoria: Let me take a note of these questions and then I can get back to you. So it is, what the weighting is of the dissertation, I don't think it's weighted, I'll double check, and it's -(**Andrew:** And even if it is, we may well allow it to be) -and if you need- you were asking if you need- if you had to get a 70 in order to get a distinction.

Alyssa: Or, 60.

Luke: (joking) You were going to give us all a 70, right?

Andrew: Your grades were already quite- your average was already quite high, Luke.

Victoria: The thing is, you're all good students. You do well.

Alyssa: The project management module, are the marks, did everyone's lose 10%? Like, did they get moderated down significantly?

Andrew: No, not at all. You guys- but you guys I made a mistake, I gave you somebody else's personal mark for your team mark, so I'm getting that to the centre, so that's going to be amended.

Alyssa: Do we have to query that ourselves? Cause like, they've sent that-

Andrew: No, I've queried it.

This dialogue illustrated the high level of openness and transparency about the mechanisms of their education. Students and staff were forthright with one another about their concerns, mistakes and uncertainties, and students took an active role in ensuring a resolution to outstanding questions about the marking system.

Staff were also forthcoming with students about their own limitations. For instance, the high level of engagement and effort staff put into SEM4ID was demanding. Andrew would often complain to me that the students needed a lot of "pastoral care." Victoria, who had experience working on engineering for development projects in the past, knew the complexities of working with communities, and dedicated a significant amount of time to ensuring the first year(s) of the programme went smoothly.

At a certain point, staff needed to acknowledge that the high level of pastoral care they had been providing for students was, to some degree, unforeseen, but it was also unsustainable. In an interview, one staff member shared that "it's a lot of work, and I can't do it next year" (interview, July 11, 2019). During a group meeting between staff and students, they discussed this issue.

Victoria: Was it clear from the beginning what support that you were going to get? So how much group support, how much one-to-one, how often you would meet your supervisor. Was that clear?

Samuel: No, for me, I think, we didn't define that from the beginning.

Victoria: I don't think we did either, really, did we. It kind of evolved over time. (**Andrew:** Yeah). But it's probably worth saying the frequency of meetings, and yeah, the contact time expected and trying to set that.

Andrew: There was a high level of engagement simply because they obviously had modules every week anyway and you guys saw me at least twice a week, I think, for most of the first semester. Um, and then you guys, so, there's-

Victoria: But is that sustainable for us?

Andrew: No, (**Victoria:** -from a staff point of view) we need to – probably not. And we probably do need to be explicit about it. And I don't know...we've had an open door policy, in effect, so you've been able to come and see me anytime and Victoria and to some extent Gareth when he's been here.

But instead of closing down the “open-door policy,” staff leaned into the problem and troubleshooted with students. They asked for feedback and suggestions on how to manage this better in the future.

Andrew: So how have you guys felt about that? Has there been- somebody's commented that's not been enough pastoral care. Now it's physically impossible for us to give any additional pastoral care because it's quite high, (laughs) (**Victoria:** Yeah) compared to most programmes.

Hari: I think that's fine, like, it might be a preference, like, I prefer that, but I think there's enough support, so.

Samuel: With me, I don't see that as a problem. What we have is already ok for me. I think maybe if people have been complaining, it started from maybe at the time that the group project, the way some sort of few issues, yeah, but I don't think all that we have done so far, the support you have been giving us from the beginning, is not enough. Yeah, it's good, because sometimes even [unintelligible] for mentorship with us to find out what is going on and I think you have been doing that from the beginning.

Andrew: Ok, good.

Samuel: Yeah, so, maybe it's more about the group project that we need to look at how we can make it best from next year to improve upon what you have done this year.

Andrew: Sure. And what you'll have is you're- we've been talking about potential additional- or an additional module, or an additional way to frame some of the work you've been doing and we need to talk about this a bit more, as well. But do you think there was a lack of, perhaps, structure, in terms of the expectations of the end result or your MSc dissertation? Could we have given you more direction earlier on in terms of what it was that we were expecting you to deliver? (observation, June 14, 2018)

In this scenario, students acted as representatives, offering their suggestions and experiences about the level of supervisory support they had received. This helped

staff moderate their understanding of and plan ahead for the level of support needed for future student cohorts.

These dynamics and relations were a departure from the typical arrangement of students and staff roles in higher education, where course structure and mechanisms are all in place before students enroll. Discussing aspects of education, such as the mechanisms for weighing and marking, and course staffing requirements, *with* students during the course of their studies upends the traditional hierarchical structure within higher education, where “decision-making in teaching and learning is generally the domain of academic staff” and where students “lack agency and voice” (Bovill et al., 2016, p. 196).

Student autonomy

Though co-creating the learning and teaching experience became a feature of SEM4ID, it was not the original intent of the course, nor was it the reason students enrolled. The primary purpose and responsibility revolved around the international service-learning component.

Within this scope, students were given a high degree of autonomy throughout the course to decide on the specifics of their individual and group projects, and to navigate the complex relationships between Swansea University and community-based stakeholders.

Students seemed to exercise their autonomy when traveling to their field sites and interacting with community partners in country. For their second time in the field, the students on the Sierra Leone team did not have a lecturer travel with them; I would be the “more experienced” person to join them. However, I would not be in country with the students throughout their entire trip and would be returning home before the team. Each student was allowed to make their own arrangements, and some travelled on their own. Luke arrived about a week before Idris and me, and Cristina and Chris made their own ways down a few days later.

To me, this signalled a high level of trust in the students on the part of their lecturers. And after spending just a few days with the students in Sierra Leone, I could tell the students were deserving of that trust. They were motivated by their

work, engaged with their community stakeholders and respectful of the risks and hazards of the setting.

Once all the students arrived, they organised a group meeting to check in with one another about their projects, logistics and the group's finances. They held the meeting at a gazebo that was about 50 metres away from the main offices of Home Leone, where the site manager and staff spent a good deal of their time. The students had some fundamental disagreements with how the managers of the site conducted their business, and although the students were not necessarily going to discuss those issues, I got the impression they wanted to be able to speak freely. The freedom to make decisions on their projects was important for their ability to maintain accountability to the multiple stakeholders connected to their projects – the management of Home Leone was only one of those stakeholders; others included the workers who were building Destiny Village, the future residents of the Village, as well as administrative and academic staff at Swansea University. Students implied this during the meeting:

Luke: ... I think Home Leone and [Home Leone manager] and those guys, they're not academics are they, they don't really understand, you know, what research entails which is why it's cool that you're looking at different materials. And I think that's one way we can add value here from an academic standpoint it's like through the tests and how you bring about the tests. I am keen to look and speak to more people about both, the cooker, and I have been speaking with people about the cooker and the small-scale cooker, and stuff as well and pretty keen to go to Njala and talk to them and take my little stove with me.

During this meeting, each member of the group took a turn explaining their progress and thinking about their projects. They discussed what support and resources they would need, if they needed money in order to advance their work, and if they had issues to troubleshoot with their teammates.

Luke: ...Did that stuff ever arrive? No...

Cristina: The Glue? Yeah!

[Indistinct group chatter]

Luke: Oh, you have it?

Cristina: Yeah, sorry.

Luke: No, cool. So I also on the side want to make a little candle powered phone charger. Prove that works and then I'm gonna try and – have a look in town for me today bro, if there's any coal pots (?) there maybe take a picture and just get a price for me, that would be really cool. If you get the chance.

Idris: Yeah, sure.

Luke: And the parts that I've got, I can take from my candle charger once I've proved that its working, and maybe put them on the side of the coal pot and looking – I don't quite know how my paper's gonna look but I quite like to kind of play the two off the other and you've got this big community run cooker, you know, which is more well suited to the slums where it's a lot of high population and a lot of rubbish, and play that off with maybe rural small scale, small stove cooking and whatever, maybe we can make that more efficient and we can make that a power solution as well for the people there. And ultimately at the end and if there's time, with the same technology, to generate electricity from the heat, could be used for the cooker and that's like a forward thing for the cooker (observation, June 9, 2018).

Though they leaned on one another to troubleshoot and brainstorm, students were free to make their own decisions and arrangements to advance their projects. I accompanied each student on the Sierra Leone team individually as they collected data, tested prototypes, sourced materials, and liaised with local stakeholders and experts. With their high degree of autonomy over the topic and direction of their projects, I learned of the twists and turns each student had navigated in order to arrive at what was their final project topic. Through this journeying, I sensed that students had cultivated a strong sense of project ownership.

For instance, Idris described to me the process for him in arriving at a water filtration project for Home Leone.

GOW: Tell me how your water filtration project has come around, like, step-by-step.

Idris: Alright, let's take it way, way back to the beginning. Initially, I wanted to sort of, lead on a project that connected with...the core reason why we came to Sierra Leone, which is the Community Cooker. So I thought, what about the Cooker, aside from building it...fits my previous experience and fits my undergraduate degree. But I also challenged me a bit, like, I didn't want to stick to my comfort zone, but I wanted to find an area within what I

already knew... do you know what I mean? So let me look at the waste management strategy, you know, how they are going to prioritize materials to be burnt, how will it be collected, sorted, etc. And then what effect that can have on the emissions, and the ash produced by the incinerator. ... So that's how it started, but with all the sort of, politics involved with the Cooker and ... Luke was like, in the middle of it all 'cause, obviously, he's dealing on the Cooker construction, and um, the project I wanted to lead on was sort of, an add on to the Cooker, I just felt as if it wasn't a secure project. So, I thought, let me, take the Cooker out of it, and just look at the waste management, sort of, strategy as a whole in Destiny Village, for when people move in, you know. So I thought, ok, before I make an executive decision as to whether or not imma go ahead with it, let me just see what else is going on around site. So, walking around site with J, having a word with him, and coincidentally at the same time there was soil in the filters down at the pump house. So I went out to the pump house, and I was talking about, you know, my experience in filtration and you know, working with membrane plants, etc. And J was saying, yeah, we're thinking about uh, grey water harvesting for our allotments, sort of, via soakaways, and I've been really trying to look into that, and I said, you know what, I'm here, let me have a look at it for you, and I thought, you know, this could make for a decent project. So, I thought, let me leave the waste management strategy to Home Leone, since they've already got something in place. And let me take on these grey water filters, you know? Like, I saw that as an opportunity to make some sort of you know, impact on the water management and whatnot, in Destiny Village. So, that's kind of how it came about, just through conversation with Home Leone essentially, and scouting out the site, seeing where I could slot in. You know?

This winding journey to land on what would ultimately be his final project was possible because Idris had a high degree of freedom to navigate the team dynamics, assess stakeholder needs and make independent decisions as the situation evolved.

At another point in the trip, I joined Idris and a local plumber (M) he was working with on the filter project, on walk down to a water pump station that fed water to Destiny Village. Idris was explaining to me the mechanics of the pump, and discussing the colour of the water, which at the time had turned slightly yellow. The two of them were investigating the pump to assess if there were any obvious faults that would be influencing the water colour.

GOW: Okay Idris, we're in the, where are we now?

Idris: We're in the pump house

M: Right, we're in the pump house

Idris: Yeah, that's associated, with like, I guess the dam, the water reservoir in Destiny Village. So at the moment, I'm looking at the filtration system here, uh, just so I can get a bit more, sort of, understandin' of how they're filterin' the water. And maybe seein' if I can see an obvious reason as to why there might be a bit of yellow colour in the water supply. Um, so right now I'm familiarizing myself with the equipment, so this is the dosing chemical (tapping on a drum), to clean up the water. That ticking, (regular ticking in the background) is a dosing pump, so every time you hear a click, it's dosing chemicals into the water supply.

GOW: What kind of chemicals are they?

Idris: So this is using...

M: Chlorine.

GOW: Chlorine?

M: Chlorine.

Idris: Yeah? This is chlorine?

M: Chlorine. Only chlorine.

Idris: The drums are different.

M: This is a different drum, but we mix..

Idris: You mix it?

M: We mix it in there. (unintelligible dialogue between M and C)

Idris: And then these are your cartridge filters. Um, so normally this would be some sort of fabric, like a membrane that would filter out, it could be just like a coconut cartridge, it could be black carbon, which is like, coal. And now this looks like the membrane to me, but, I wanna check to see if there's any sort of...

M: ... not on...(unintelligible)

Idris: Yeah this is the UV, (M: the UV filter) the UV filter, it's not on

M: Yeah (unintelligible)...(talking with Idris)

Idris: Yeah, the UV filter is not on

M: (unintelligible)

Idris: Yeah, the UV filter's not working. Which I suspect could be responsible for the colour, as well, which doesn't mean it's a bad thing. But like, UV is like, you have your chemical for your filters, and the last layer is like, germ killing (G: Yeah) so filtration with the UV, you don't need it to have safe water. But it's interesting actually. Do you know what rate this dose at?

M: Sorry?

Idris: Do you know, uh..

M: The dosage?

Idris: The dosing rate, yeah.

M: No, I don't. Because I don't have the testing right now.

Idris: Ok ... (observation, June 7, 2018)

Though fixing this potential water pump issue was not necessarily within the scope of his project, Idris was motivated to investigate it and to work closely with the local plumber to better understand the current water filtration system that Destiny Village had in place. And he had the freedom to do it.

The students on the Sierra Leone team generally seemed content with the level of autonomy they had. During an interview with one student after the second field visit, they reflected on the differences between their two field visits.

GOW: ...what was your impression you know after now two trips in the field?

Cristina: I think the second trip was much better than the first one.

GOW: In what way?

Cristina: It's I don't know. First, we were feeling like because we knew the place we were feeling much, not safer, but like when you go first time you don't really know what to expect and this time we already knew. So, and then I think like we could choose whatever we wanted to.

GOW: Yeah.

Cristina: That was the main part.

GOW: Yeah.

Cristina: Like I'm not saying the academic way. I don't know if Andrew or Victoria were there it would be different. But we could choose what to do and that was really good. It's like we weren't stuck with a person. So, it was quite good with freedom and then we could go everywhere the way we want. Yeah, but I don't know maybe if they were there this time it would be the same. I don't know. I'm not sure though.

GOW: It's hard to know.

Cristina: Yeah. It's like first time Andrew was quite relaxed. Victoria started a bit unsure and then she was relaxed a bit but then if they come this time, I don't know. I don't think we would be as free as we were deciding things and doing our own plans and stuff.

GOW: Yeah, I've heard that.

Cristina: It was good. Everyone was doing what we wanted like Chris, oh I am going there. At least we were telling each other what we were doing anyway, so.

GOW: Yeah.

Cristina: But we were free to go wherever we wanted. That was good, really good.

GOW: What about having that freedom is good?

Cristina: It's just. I think for the decisions, you can make your own decision and that's a good part you can choose. You don't need to follow what people tell you. You are choosing because you think this is better for your project and you can do this. I think the power of decisions is good. And as well like we could... we went in a motorcycle. I don't really know if we could but we did and it was much faster and we could do more things like at least in the day I arrived. We did so many things in the afternoon, just in the afternoon because it was much faster and then, I think the car would be getting stuck and then, yeah so. I think it is the decisions.

GOW: Yeah.

Cristina: Is important.

GOW: Yeah.

Cristina: I think it's that really. I don't know. It's hard to think about it but yeah. Freedom yeah. We were more free and even like to talk when the

conversation I think. I don't know if we were feeling restricted in the first trip but in the second one we were talking about anything and then maybe because it was just four of us like silly things and stuff.

GOW: Like with your team members?

Cristina: Yeah, well maybe like yeah, it's just like with them and then with people in Home Leone, so we were more free to say whatever we wanted. I don't really remember like a specific conversation but we were more expressing more maybe.

GOW: Yeah.

Cristina: I think. Yeah. I don't really know like a proper conversation to tell as an example.

GOW: That's okay.

Cristina: But say I feel we were more free to talk and say about it.

GOW: About like your experience the project or something else.

Cristina: Yeah I think any conversation. I think sometimes we think because Andrew and Victoria are in a different level than us in a different position, maybe we should select what we say really.

GOW: Yeah.

Cristina: So yeah just that I think. It is a power position I think and I know they were there like in the evening, they are not our teachers but even then. (interview, July 12, 2018)

Though the Zambia team was accompanied by a number of staff, they made many of their own arrangements for meetings and for carrying out their research. From the first day in country with the students, one of the MSc students, Samuel, started meeting with participants in his research study.

This was our first full day in Zambia. Yesterday, when we arrived at the airport, I noticed Samuel was on the phone right away, getting in touch with people to arrange meetings. (observation, August 8, 2018)

I sensed it was due to his diligent planning even before arriving that he had a meeting set up for 10:30am that day with the with a Senior Quantitative Surveyor (Mr. C) at the local Municipal Council. The rest of my time observing this student throughout our time together in Zambia would be like this – he had multiple meetings arranged

each day. He was persistent, as well, recognizing that he was engaging with people who had priorities other than helping him with his research.

Samuel called him but couldn't get through. We ended up loitering for a few minutes in front of the Civic Center, half just to chat and debrief, half to wait to see if Mr C would call Samuel back. As we were about to give up, Mr. C came down the path toward the Civic Center. Samuel was eager to get in another interview/ questionnaire before breaking for lunch. Mr C smirked and chuckled – I got the impression he was amused by Samuel's ambition, but also was a bit patronizing, or maybe he had lost interest in putting a lot more effort into making arrangements for us. I got that hint, but Samuel pushed more to see if he could meet with anyone who does procurement in any other ministries, including health, education. I wasn't sure at that point whether Samuel was getting the hint as well and pushing regardless, or he didn't see that Mr C was losing interest. In the end, Mr C offered to see if the building inspector was available, but that was the only other person he was able to make arrangements with (observation, August 9, 2018).

Later that day, I ended up asking Samuel if he noticed that Mr. C was trying to move on with his day, and he was aware of it, but decided to be assertive anyway, because though Mr. C seemed somewhat interested in helping him, he knew that he was also busy with his work. And he would need to push in order to get Mr. C to follow through on helping him. His ultimate concern seemed to be getting enough participants to take part in his questionnaire.

GOW: ...how do you think it's going?

Samuel: Oh it's been quite challenging. In getting participants because this is a new place. It's not a familiar land and I don't know people by myself, I depend on someone though even though before I came I had done arrangements, but it has been challenging to get those people. Some of them have other commitments which obviously that is what they are being paid, so they prioritise around my work. But notwithstanding the few that I have spoken to have been very good and they have participated in my survey...(observation, August 9, 2018).

Despite, or possibly because of these challenges, Samuel was thrust in a position where he needed to learn as he went how to manage relationships and time, in order to gather the data he was hoping for to complete his dissertation. He ultimately managed this successfully on his own and would be able to take the skills he developed from the experience into his future practice.

A learning space

Students had clearly been thinking about the relationship between their classroom and applied learning. During another meeting where students and staff discussed the course structure and content, students fed back that they would have liked to learn more about monitoring and evaluation before they went on their first field trip.

Andrew: ...Generally, your feelings on the modules, just broadly? Are you happy with the selection of modules? Do you want to give us you feedback on the modules? Module order et cetera, et cetera. We've had a little bit of feedback from the other team, so we'll interject with that.

Hari: Like the modules itself, I think they've been alright. Just the timing of the modules. For example, the Tools for International Development and things like that. Maybe it would be better if we do it at the very start. Uh, and like, just the, like the leadership and things, I think that could wait a bit later. But like, you know, even like Monitoring ... maybe it would be ideal if we do it at the very start, before the scoping trip, so that it would be beneficial, 'cause you understand it a little bit more, I guess (observation, June 14, 2018).

In a later conversation with Hari, he described how the hands-on, interactive learning environment helped push him out of his comfort zone and grow.

Hari: I feel like because we had so much interaction with so many different people throughout this course I think that actually helped me when I was in Zambia or even when I was working here because I was much more open to talking to new people and presenting my ideas to new people without actually thinking about it too much and I guess there are drawbacks with it but I feel like that helped me much more to actually understand new perspectives throughout the course (interview, September 13, 2018).

It was not only the students on the SEM4ID course who were learning all the time. Lecturers involved on the course were actively engaged in learning and were often open and transparent with students about their own learning, as well.

Victoria was public about her experience with pain as she was confronted with new understandings of her identity as an engineer. She had never questioned her engineering identity before her engagement with SEM4ID. But through her interactions with students and engagement with their processes of critical reflection, she began to realise that the way that standard way that engineers think about the

world and approach problems may be inherently problematic. I explored this learning journey and how it impacted her teaching with her during an interview.

GOW: I've seen some your presentations where you bring up the concept of pain as part of your journey. I wonder if you could expound on what you mean by that, what that has been for you.

Victoria: So that really only happened in a in a powerful way with SEM4ID... because that was the first time I questioned, engineering as a profession, and I think up until SEM4ID, I hadn't really questioned the validity of the engineering method or engineers. I kind of felt secure in my identity as an engineer and I offered something because I had my experience in the process of the PhD, and I understood that world and it was ok and I didn't really question it... so I'd felt frustrated and I felt inadequate when it comes to teaching, I guess, so when I realised I couldn't teach, I didn't know what to do, and...I felt uncomfortable and I felt, um, I felt inadequate and I felt like I had to improve ... I had to read, and I had to ask other people, ask my mentor what to do in the situation. Um, but it was only really SEM4ID that affected me in a, in a deep way and that was after the first year and when I'd been in the field with the two teams and I'd just seen the engineers not get it.

GOW: What is "it"?

Victoria: So when they're faced with an issue, the engineers would, um, they'd drill down to a solution way too quickly and they wouldn't stay open minded. ...that's what I was finding with the engineers in the field...they would pay lip service to looking at lots broad solutions, they would fixate really early on one and then almost discount and shave off everything else and get more and more ...detail(ed) on how the fine details of that solution would work, without questioning whether it actually is the right solution. Whereas the social scientists in the group really resisted that and they wanted to look more and talk more and ask more questions, and the engineers would then fight that and say, well no we need to make progress here, otherwise we can't deliver the project. And it - that was the pain for me was in watching, it was painful for me to see that the engineering method and what I'd always taken for granted as being the effective engineering method, wasn't effective, not in that context and that, was hard for me to take, because that was not something I'd questioned before... (interview, July 11, 2019)

She described how this tendency showed up amongst the student teams in SEM4ID, even into the second year that the course was taught.

Victoria: And again this year, I'm just thinking about this year's students as well, the same thing is happening in Sierra Leone ... They just wanted to have their framed [problem], they wanted something to do, so what's the next task on our list, where we've got to put the insulation up, and ... they really weren't thinking about the longevity or sustainability or how this technology is going to fit in. They wanted to deliver it and have it and then they were gonna think about that. And it's, it's inverted... yeah, and it goes back to the way that way we teach (interview, July 11, 2019).

She went on to expand on her concept of the “engineering method” and the way it is taught at the University level.

Victoria: ... as soon as you fixate on a solution, we hadn't really gone back and questioned that solution, we'd just gone further and further into designing it... And it made me realise that, that the way that we teach and the way that engineer education is, and it is very problem solving... you're given a problem and you have to work out a solution, that's training that into the students and students don't necessarily want to challenge authority or challenge themselves or challenge the question. They almost panic when they have that broad canvas and they're not comfortable, and so as soon as they have something tangible that they can sink their teeth into and understand they're happy and in their comfort zone, and so they then get in their flow. Because then, well I got my feet right, I know what I'm going to design now, I'm going to design it. Before they know what they wanna design, it's just stress... I think it's because they just don't know how to deal with that ... (interview, July 11, 2019).

Realising that she did not have the tools or knowledge to train students any differently confronted her sense of self and her abilities in teaching.

Victoria: So then it was the fact that I had to confront that I don't know how to teach what I don't know and I'm also clearly one of those people who just, certainly at that time, probably still, ... I want to have my framed problem so that I can then get to work. I don't want to frame the problem because I don't know if I've got the knowledge to do that. I don't know if I have the words to do that. They don't have the words to do that. I don't know if I've got the, the breadth of experience that's really needed to make a proper judgement. So how can I teach students to do that if I can't do that?

She went on to reflect how her experience confronting the limitations of her training has enabled her to critically reflect on the nature of engineering higher education in general.

Victoria: Something really needs to change because that's not what engineering is. Engineering ...isn't following set procedures anymore. It used to be, and I think that's why it's taught that way when I was taught that way. Because we didn't have high power computers, so you would have spent all your day doing computation and yet now we've got computers that do that for us. And the job of an engineer now is to run multiple design simulations in a day with the click of a button, and then look at them and evaluate them. Whereas before you never had to. I never, there was, there was less of that even when I was working. And certainly 20 years ago when people here were being, um, taught, they were taught an appropriate manner because it was a job to be a little human robot, a human computer and compute. And that was ok. But yet we still teach this way, uh, where we expect students to be able to rattle off a complex indeterminate structure calculation. And yet they never actually have to do that. They never have to sit down do those calculations ever again, what they will have to do is work out: is it the right structure, is the most efficient structure, is it going to be able to dismantle easily, it is sustainable, how's it going to affect, what's the CO2 footprint. And... we don't really teach, talk about still, we're still stuck in the past...I did it the same. When I started teaching, I taught in the way I remembered being taught, and I tried to emulate the lecturers I really enjoyed. But it was still stuck in that very information giving space (interview, July 11, 2019).

Her investment of time and energy into working on the SEM4ID course was in part, a way for her to make change in engineering education.

Andrew learned a hard lesson about his own epistemic blind spots not long after I started my doctoral work. During a meeting, he talked to me about how he had been realizing that especially with the Zambia team, he “messed up” and gave them a solution to work on, rather than a problem (observation, March 15, 2018). This framed the solution as an engineering problem, rather than a social problem that *may* need a technical solution. This resulted in the engineering students “burying their head deeper into the technical stuff,” moving away from interrogating the fully complexity of the problem of delivering education to children with special educational needs.

Later, in an interview, he acknowledged this was a “light bulb moment,” recognizing that he had been driving student projects based on what the school administrators said they wanted and based on what the Discovery Charity was reporting that the school needed. But he “started to get the message slowly that kind of some of the ideas weren't that good an idea, but I was still pushing them because

for me, it was about, you know, educating the students, and getting the students some experience, as opposed to trying to do both, educate the students and solve a genuine problem” (interview, March 27, 2018).

This lightbulb moment opened him up to how social science can support the development of more appropriate solutions, whether technical or non-technical.

Andrew: ...what I realized is that you needed to do some of that social science, and I still don't have a full understanding of all of it, I wouldn't even claim to. But I do know that, you know, engaging, and using the tools of social sciences to engage with the-the stakeholders, the end users, the community, it's really, really important. And having some evaluation, some way of measuring whether the things you're doing are a good, you know, work out and actually turn out to be what you want them to be, is also, pretty smart. And thinking about this all the way along the line, asking the right questions, all of that. And then having a nice framework into which to then implement engineering solutions, and if necessary... (interview, March 27, 2018).

This learning influenced him to think “outside of this ... black and white engineering realm,” which he acknowledged felt “healthy” to him.

Impediments to enacting a critical pedagogy

Disorganisation and mismanagement

Though there are many benefits to the “start-up” approach to challenge the status quo, I also perceived a start-up style of *disorganisation* around SEM4ID. I attributed this in part to Andrew's leadership and management style. I did agree with other opinions of Andrew that he had strategic vision to catalyse new projects and programmes. The Head of College (HoC) at the time seemed to regard Andrew highly and give him the latitude to act with wide remit. In one meeting that Andrew pulled me into, the HoC commented that Andrew would often have “mad ideas” and then goes on and does them and, to him, they would often turn out great.

However, he had a lax management style, and would often leave the bulk of the administrative and implementation of his ideas to other people. For instance, Andrew would schedule meetings with a stated purpose, but fail to organise and lead them. I reflected on one such meeting that Andrew had scheduled with the HoC and

both SEM4ID and ELM students, the purpose of which was to give students an opportunity to cross-pollinate their learning. What sounded like a good idea ended up falling flat.

He was late to the meeting with [the HoC], he had people waiting here, there and everywhere [physically, around the building – we had to walk around to find everyone and bring them to the meeting room]. There was supposedly a meaningful conversation or some presentations to happen between 2 sets of MSc students, and lunch, but it ended up being a bunch of people together having random, unstructured chats. It felt like a huge waste of time. I think he needs an executive assistant to help keep all of his many balls up in the air, instead of falling all over the place (observation, March 23, 2018).

On another occasion, Andrew organised an evening event to market the SEM4ID course to prospective students. Though his event was able to attract many students, I knew it was due to the hard work of (female) staff on the marketing team. At the event itself, the food and beverages promised were not there, so Andrew asked me to go to a local convenience store to purchase enough for the event.

I remember feeling a certain resentment toward Andrew at the time, which was, in part driven by the fact that I saw the women around him, me included, often picking up the slack where his management and implementation skills fell short. It seemed wrong that he would get credit for having “mad ideas,” and the women around him would get less credit, though they picked up a lot of the more difficult tasks of seeing the “mad ideas” through. Yet it appeared that Andrew carried a status in the department, despite his lack of follow through.

The establishment of the SEM4ID course itself was another such example. Even though the programme did get approved by the relevant academic quality boards and committees and was a course that seemed to have a great deal of value to staff and students, the foundations of the course were built on shaky ground. I attributed this, in part, to the way that Andrew had thrown things together to launch the programme quickly after getting the PoW endorsement and corresponding push from the HoC. He described how this occurred during an interview.

Andrew: ... when I, sort of stormed the idea, it was based on the fact that I had not long come back from Liberia, I was working in China, I was heavily invested into putting my time into commercial activities and I had been a bit

affected by, well you know, very positively affected by my trip to Liberia, and the learning experience the students had got out of it ultimately... So I'd mentioned to the big boss about setting up a potential course, and he'd mentioned it, and somehow it got up the chain to the Prince's Foundation, to the Prince of Wales himself apparently, and it came back down to me as an instruction to kind of make it happen... (interview, March 27, 2018).

The lecturer on the course with more field experience in international development contexts acknowledged how rushed the launch of the course felt.

Victoria: I can't even remember how it all came about now, it was all really last minute. And we only recruited the students with weeks to go before the term. And I wasn't really involved in the setup of the modules. That'd all been done already (interview, July 11, 2019).

This lack of thorough planning and subsequent disorganisation reverberated throughout the course and impacted student projects. I noticed that the lack of management of the different disciplinary elements of the course led, in some cases, to a disjointed learning experience. Because SEM4ID was not managed as a cohesive, integrated course, there were subjects taught and assessments assigned that had little to do with student dissertation projects. This resulted in considerable effort put into learning that had little application, and vice versa – that there were important learnings in the taught modules that were not effectively applied to learning in the field.

During my time with the Sierra Leone team in country, students reflected on some of the modules they had taken and how they were mis-matched with other lessons they had learned from other modules and their field experience.

Chris: I'm trying to think what my favourite module was. I didn't actually really enjoy circular economy. I think that's 'cause it was really new for me.

Idris: I liked it. It's just, unfortunately the assignments fell during the [unintelligible, wind]

Cristina: I liked the theme, like, the subject, but I didn't really like how the classes were...

Chris: No, yeah, no, that wrong (one?) class

Idris: I didn't feel like the examples used really relate to what we were doing.

Chris: Yeah, it was much more like Gareth's solar power agenda, wasn't it, yeah.

Idris: Yeah. And because of that, like, I don't think I was engaged- as engaged as I could have been. Cause when you're droning on and on about solar panels all day and like, I know nobody's using that info any time soon.

Chris: And none of us knew about any- like, we had one class that was like, all afternoon in a small room. And, like, for me who has no idea about science, like, whatsoever, I literally couldn't even listen, like, 'cause it was just like a foreign- it was genuinely a foreign language to me.

Idris: D'you know what's funny, though. You know the assignment, you have to do a presentation, you have to do a presentation on like, how we design a village to meet certain sustainable development goals, right? So, after all the work we did on solar panels, you would think that, in our presentation, we would have incorporated solar panels in our village. We just totally scrapped the solar panels altogether. And I'm not sure how Gareth took it. Cause he was like – his first question was why didn't you guys use solar panels? And it's like, are solar panels the only option, like? (observation, June 10, 2018)

During a debrief with one of the students on the Zambia team after their second field visit, he reflected on some missed opportunities to provide support to their community partners because the team had not properly assessed the problems they would be facing when he arrived.

Hari: Maybe setting it up so it only has one server and it is easier to use but we couldn't do that because we didn't really have the resources and we didn't really know what we had already before the trip so I should have maybe asked a bit more about that before the trip itself so that I would know exactly what the problem was (interview, September 13, 2018).

I was surprised at this because students had learned about assessment methods in their taught modules. However, the modules in which they learned these skills and were assessed did not directly link up to their field visits. They did have a concept development module, through which they developed plans for their technical projects. However, concept development focused on engineering design processes. Though there was space for critical reflection, there was less emphasis on using social research methods to scope and define needs. Andrew, as the programme coordinator, had not accounted for this.

In reflecting on the multiple instances of Andrew operating in this way – empowered to act by the HoC, yet not held to account when his lack of planning or follow through impacted others – I could not help but wonder if there was some relationship between Andrew’s gender and his high standing in the CoE.

The differential social standing and opportunities for advancement between men and women in the workplace is well documented across sectors, yet is exaggerated in organisations with strong engineering cultures (Robinson & McIlwee, 1991). As discussed in the introductory chapter of this thesis, the culture of engineering is defined by depoliticization, meritocracy and a technical/social dualism. Robinson and McIlwee posit that the culture of engineering also “values behaviors and orientations consistent with the male gender role” where “competence is a function of how well one presents an image of an aggressive, competitive, technically oriented person” (Robinson & McIlwee, 1991, p. 406). In sum, men tend to hold more power and status within a culture of engineering.

The ways in which Andrew was enabled and empowered in the CoE suggested the possibility of a broader sexist culture, consistent with a culture of engineering. Though he was only one individual, the ways in which Andrew operated did not occur in a vacuum. Andrew faced few, if any, consequences for his management style, and was allowed and sometimes encouraged to operate in the ways he did.

Inappropriate Student-Practitioner Balance

A crucial dimension of learning through service-based experience is creating space and scaffolding for students to become practitioners. Providing students with a degree of autonomy to engage and manage relationships with community partners within the context of their education allows them to cultivate the skills of practice within a protected environment. Teachers and coordinators of such programmes must take into account the inherent risks and challenges of providing novice practitioners with autonomy. Students may not be prepared to negotiate across the power differentials that often exist between university and community-based stakeholders. Structuring a learning environment where there is an appropriate balance of responsibilities for students to be students *and* to be novice practitioners is

challenging. It requires risk taking and artfulness on behalf of the teachers and/or coordinators of such a programme.

In the case of SEM4ID, giving the students a high level of autonomy over their projects appeared to be intentional. The course was aiming to provide students an opportunity to critically interrogate engineering interventions and through that interrogation, be able to assess and identify needs and design solutions that would be in line with the community stakeholders they were working with. Andrew, in building the course, envisioned giving students “control and freedom and asking them to ask questions and training them to do the right thing” (interview, March 27, 2018). Another staff member on the course acknowledged that they were trying to do something different than “just another placement-based ISL course” (personal communication, October 10, 2018).

I recognized that a bit of experimentation and risk taking may have been a necessary process for learning how to deliver a course that was fundamentally pushing the boundaries of what had been done before it. It was almost as if through experimentation, SEM4ID was helping illuminate where the boundaries were.

Yet the reality of delivering and graduating students from an educational programme that would meet University standards for managing safety and risk, maintaining academic quality, and providing the spectrum of skills and knowledge to students in order to accomplish this was far more complex than was initially expected. Andrew admitted to me during an interview that “it was a bit of naivety” that he did not anticipate this earlier on in planning the curriculum. Another lecturer, who had more experience doing volunteer projects abroad, did have a sense of the challenges of managing the various responsibilities of delivering an educational programme with an experiential, international service-learning component. Part of the reason she got involved with SEM4ID in the first place was to contribute her experience, but also to help manage the complexity of the programme, given Andrew’ naivety.

Victoria: ...it was also something I felt like I had something offer because I had a little bit of experience, and I knew the difficulties and I didn't have a starry-eyed image of it. And I felt Andrew did. I felt the program director was a little bit um, yeah, a little bit too positive about how easy it, all was going to

be. And I really didn't think it was going to be that easy (interview, July 11, 2019).

I wondered with more planning and reading the literature in areas such as problem-based service learning in international development contexts, would Andrew and his colleagues have been able to have anticipated these types of issues and mitigated them in advance? As discussed in Chapter 1, there are a number of similar pedagogical and curricular approaches, which have been developed with strong theoretical and conceptual frameworks and studied and reported on through the peer review process. For instance, project or problem-based learning through international service projects is widely implemented throughout US universities. International service-learning projects have also been robustly critiqued, and attempts have been made to improve on them.

Indeed, one lecturer who was heavily involved in SEM4ID admitted after the first year the course was delivered that they still didn't "have the right balance yet" in managing dynamics between students and community partners. She realized they had not prepped the "partners enough on the balance between student-practitioner" and it was "because really we hadn't decided ourselves and were waiting to see what evolved." During the first year, this may have been exacerbated by the fact that students, staff and community partners had not developed a Terms of Reference.

Throughout my period of observation, there was increasing evidence that the appropriate student/practitioner balance had not yet been struck. For instance, during their first field visit, Andrew informed me of some "ball ups" amongst the students. One student had gotten malaria. One student had travelled with a knife. And one student forgot to travel with their biometric residence permit and was not able to return to the UK with their team. These incidences signalled that students may have had *too much* autonomy to manage themselves through the programme.

Later in the academic year, I learned of a scenario where a student on the Zambia team realized he was being taken advantage of by a community contact.

Samuel: I think the first one was there was one guy who wanted to take advantage of me because he was giving a lot excuses. I told you earlier you might have forgotten.

GOW: I remember.

Samuel: I asked him to do the arrangement for me and he asked for, he was the person who recommended the letter of introduction. I sent to him but before I went to the field, he was not responding to any of my messages, the emails and calls and whatever till I used an unknown number to call him in-country. Then he said he said that he was going to do it. He called later that the organisations within the town are very far from each other and I needed mobility, I needed transport. So indirectly I realised that he was asking for money to do that for me. But I understood it because the situation was almost like in Ghana. People generally have the perception that for someone to come from Europe and come to a developing country like Zambia he must have all the money to do that, so it's an opportunity that you can tell a story of which might not be the case that at least to create a problem and get something out of the problem. So that's what I saw it because I knew that that particular location Monze is not that big and the government organisation predominantly should be close to each other. Because when I eventually went... I didn't have any vehicle, I walked, and so I expected him to do it but so that is what I find odd. People have the impression that when you're coming from here you are rich, so when they do anything for you they should capitalise on that so that was one of the challenges.

That student seemed comfortable enough to manage this situation on their own. But not all students were comfortable with the high level of autonomy they were given. During a meeting about their dissertations, students were asked how prepared they were feeling, and one student was particularly vocal about their concerns.

Victoria: Any big concerns? Any questions you want to ask me now before I start, so I make sure I address them this morning?

Becky: I feel like, well I've got an idea. I don't feel like I have the most support in the world. I just feel like I'm being pressured for a lot logistics I don't really know yet, coz still working on the big idea of the dissertation. So I don't know those small details yet, but I'm being asked to do them because our whole thing is kind of caught up in the summer trip.

These concerns were somewhat mitigated through peer mentorship, which was fostered by academic staff mentors. Becky was on the Zambia team. Recognizing that the Sierra Leone team had had very different experiences and academic advising, Victoria encouraged students from the two groups to share the advantages and potential disadvantages of having structured plans for their field work.

Victoria: Yeah, (**Becky:** yeah) yeah. It's difficult. It's been the other way round for you lot, hasn't it really?

Cristina: Yeah, well, I just start reading, really. I haven't done much yet, but uh, yeah it now- I think when I was there, I didn't have a clear idea, but now after talk with you from the trip I have a much better idea now what to do. So maybe it help you, like with the details, maybe, after the trip-

Becky: Yeah, it certainly helped. So I saw Cristina last week when we got back. It really helped speaking to you, like, things made a lot of sense. The advice you'd been given and stuff. I was like, ah, yeah. But yeah, it's funny coz we have kind of done it the other way round.

Victoria: But there's advantages for you doing it. Because what I feel about the way you've done it is you've gone out there without much prep really, and you kind of do a lot of reading now and you'll probably find things now that you're reading now that would be really useful to consider and have.

However, these conversations did not fully ameliorate the tensions that arose between students and community partners, particularly for the Zambia Team after they backed away from building the school building for SEN students. Becky expressed this during an interview after her second time in the field, in response to a question about the challenges that arose for her during her trip.

Becky: Maybe not a challenge to getting the work done, but certainly a challenge for my comfort, during that introductory meeting, the stakeholders at the school felt like we were still going to deliver a classroom and we're the people that are going to deliver that. But following the insufficient funding from the Uni, that was clear that wasn't going to happen, and might not happen next year. And there was no correction of that from my point of view. I thought it was a challenge because I could recognize that what we were there for or what we might be there for in the future might have a different understanding from our side and I felt that we were deceiving them, but I didn't feel like it was my place to say because I'm not the person who will be taking this forward, who will manage how other people might approach the situation going forward – I don't have any authority to put this through (interview, October 4, 2018).

Becky seemed to feel that though she had been granted autonomy over the fate of the relationship with community stakeholders, she would not ultimately be managing the relationship in the long term. For the Zambia team, increased involvement from SU staff may have helped both students and Siavonga Primary School partners establish

and maintain clearer expectations throughout the course of the academic year. It may have helped avoid tensions that arose due to unfulfilled and unfillable expectations that the Primary School partners had of the students. And it may have helped with continuity of the relationship and project after the first cohort of students graduated.

Increased involvement of staff may have helped avoid a coercive scenario that arose between students and partners in Sierra Leone. During their second trip to Home Leone, the Sierra Leone team were confronted by the dominating personality of the British site manager (referred to as “J”). After their trip, one student she told me about her role in managing funds that were given to the team to spend in country on their project. She explained how J ended up pressuring the students into giving Home Leone a donation, which was beyond their original agreement.

Cristina: I felt so bad because I arrived with the money and then I said oh Chris, I’m not staying with this money with me because everyone is entering the rooms all the time so I said should I give it to J and then he put it in the safe but I gave him like, an envelope of my passport and stuff.

GOW: Right.

Cristina: So he opened and he counted the money because he told them both of them saying, like oh I knew you have money with you. You bought a float with you.

GOW: Yeah.

Cristina: So whatever you can help with something like that.

GOW: You basically got frisked.

Cristina: Yeah so I felt really bad because the money with me but I put in a safe thinking like if it is in my bag it is possible I don’t know.

GOW: Yeah and you couldn’t have known.

Cristina: It’s a thousand pound. A thousand pounds is quite a lot. I think.

GOW: Yeah.

Cristina: Especially as it is not my money I can’t lose that.

GOW: Yeah. No well. I don’t know.

Cristina: It was with my passport and stuff.

GOW: Right. Right.

Cristina: So he opened it and he counted it.

GOW: It doesn't sound right to me.

Cristina: No.

GOW: And it's not your fault. It's not like you shouldn't feel bad at all about it.

Cristina: Yeah.

GOW: He took advantage.

Cristina: But then when yeah when they talked with Chris and Aaron it was like I felt bad for them because...

GOW: Yeah.

Cristina: He pressured them. (interview, July 12, 2018)

Though one student tried to stand their ground with J, in the end, J was able to solicit additional funds from the students. Had there been a more senior or experienced university representative with them, they would have been in a better position to intervene with J and push back against this coercive behaviour.

In each of these vignettes, it is possible to get a flavour of the wide variety of scenarios that any practitioner may face when engaging in cross-cultural community-based field work. During the first year of SEM4ID, inadequate planning, preparation and management, paired with an inappropriate degree of student autonomy left some students in compromising positions. In the context of an educational experience, given what has already been learnt about managing and structuring ISL projects, the level of autonomy granted to students may be considered on the border of irresponsible.

That said, the final result of the learning experience amongst students and between staff and students was still a powerful one. It may not have manifested this way if there hadn't been space for improvisation and experimentation. On reflecting on his level of preparation for field work, one student shared his perspectives with staff and students during a group meeting.

Luke: I was fairly ready, I think. Um, you know, I think it's a trade-off really. You know, I could have gone a week later and had a bit more time to prepare, but then it would have been a free, it would have been a week short of ... realistically in terms of what we achieved, because the rains really start to kick in at the end there and then, you know, and...there's certain priorities that people have there, which weren't the cooker, right? J's trying to run a construction site. So, it's when you show up and you're like, you say to CCF, and I'm here. That's when they're like, okay and you say you've got four weeks and you may be help for a little bit more, but you don't say that because ... things really kick in in that last week or the last couple of weeks, when people are like, oh you're running out of time now, you know, time goes quick and it goes even faster in developing countries, I'm sure. Um, so, I don't know as I would have traded a week of more prep, and I guess I was perhaps a little bit naïve about how much academic work I could do there? How much reading? Because I guess that's personal, but you know, if the guys were out there working on the character from eight 'til five, I wanted to be there with them, because I didn't want to be that Western person, or, not really a professional, that Western person which shows up at ten and then leaves at three, and then just tells people to do, like, you know I mean? (observation, July 10, 2018).

This reflection sheds light on the fact that there may not be one right way to strike the student-practitioner balance. Some students, like Luke, will be comfortable to grow into their practice with high levels of autonomy. Some students, like Becky, will be more comfortable and gain more from an educational experience that is more structured. Given the high variability in student preferences and learning styles, the risks and unforeseen circumstances that arise in ISL projects, teachers and coordinators of these styles of programmes may consider erring on the side of caution. They may want to overprepare and ensure there are high levels of staff resources to support students through their projects, as well as ample resources to continuously manage relationships with community partners.

However, these instances of inappropriate student/practitioner balance also indicate another cultural ideology within engineering that may have been present in the establishment of the course – the devaluing of non-technical knowledge. Though Andrew seemed to have “light bulb” moments throughout that first year of running the SEM4ID, there still seemed to be an absence or an invisibility of non-technical knowledge applied to the planning and implementation of SEM4ID. Andrew, who was trained as an engineer and worked in engineering industry before returning to

work in the higher education context, had been thoroughly shaped by a culture of engineering. In leaning on experience and his network to inform decision making about the set up and management of SEM4ID, his engineering socialisation likely held influence, whether conscious or not, on how he approached developing SEM4ID. On one hand, breaking the mould of traditional engineering education seemed to be his goal with creating the course. On the other hand, his overreliance on his engineering experience and networks may have exacerbated the student/practitioner imbalance. It seemed rare that Andrew referred to the literature or other written sources to inform practice. Yet the challenges of community engagement work, particularly in international service contexts, are well-documented. Even if he had not done much reading on the subject, further enquiry into international service work amongst experienced practitioners would have alerted him to some of the pitfalls that staff and students ultimately fell into that year.

Multi-/Interdisciplinarity

Integrating non-engineering coursework, or “liberal education,” into engineering education has been advocated as a way to break down hegemonic ideologies of engineering. By introducing a more holistic curriculum, students, as they form into engineers, are exposed to more varied ontological and epistemological perspectives (Downey, 2014). Nieusma suggests that integration of liberal education courses into the engineering curriculum can promote social justice in engineering (Nieusma, 2013).

In the following section, I explore the ways that SEM4ID pushed the boundaries of the traditional engineering curriculum by incorporating a multi- and at times, inter-disciplinary approach, through the enrolment and formation of *interdisciplinary student teams*, and application of *multi-disciplinary coursework*.

Interdisciplinary student teams

The goal of having multi-disciplinary student teams was in part, to push the boundaries of engineering problem framing beyond a narrow technical focus. Andrew explained this to me during an interview.

Andrew: I guess I’ve been having an ever-increasing discomfort with, with engineering in academia, I suppose. It- I’ve always been uncomfortable in the

academic environment anyway, because I'm not really a researcher, I don't really care about, I don't know, the detail on a gnat's ass, in engineering's problems, it doesn't interest me, it never has done, I kind of got through it. What interests me is- is the power of engineering, the power of good engineering in terms of actually improving people's lives and making people's lives better (interview, March 27, 2018).

Ideally, by embedding social science students within teams of engineers, students would be able to critically question one another and push one another to approach problem solving from different disciplinary perspectives.

Andrew learned the value of a social science perspective through practice. As an engineer by training, he was taught to approach problem solving in the traditional way. But, beginning with his experience with students in Liberia and continuing while working with engineering students on the SEM4ID course, he increasingly understood the various ways that a social science perspective was crucial for broadening the scope of engineering problem solving. He described this awakening during an interview.

Andrew: I started to get the message slowly that kind of some of the ideas weren't that good an idea, but I was still pushing them because for me, it was about, you know, educating the students, and getting the students some experience, as opposed to trying to do both, educate the students and solve a genuine problem. And I- what I realized is that you needed to do some of that social science, and I still don't have a full understanding of all of it, I wouldn't even claim to. But I do know that, you know, engaging, and using the tools of social sciences to engage with the-the stakeholders, the end users, the community, it's really, really important. Em, and having some evaluation, some way of measuring whether the things you're doing are a good i-, you know, work out and actually turn out to be what you want them to be, is also, pretty smart. And thinking about this all the way along the line, asking the right questions, all of that. And then having a nice framework int-into which to then implement engineering solutions, and if-if necessary, then go and look at a gnat's ass, and figure out how to integrate that gnat's ass into this, into those solutions. There's nothing wrong with that cutting edge research if it's used in the right way. But I guess it's just, for me, starting to ask the right questions. And I should have learned a long time ago, that I've, spent many years arguing with my wife, who is a social scientist, about these sort of things, and you know, she's often challenged me, and you know... outs- outside of this sort of black and white engineering realm, it feels healthy to me and it feels like, things on a technology front are moving so fast, at-almost

out of control and people are just doing the science just because they can...but it's the "whys" and the "should we do its" that completely are getting forgotten on a bigger scale (interview, March 27, 2018).

There did seem to be benefits that stemmed out of this approach, particularly in having engineering students work with students from a social science background. One engineering student, reflecting on working with the social scientist on his team:

Hari: And even like actually working with [social science student], even though we think about it so differently I kind of understand what she is saying a bit more now, now like I have done this whole degree I understand the issues she brought up throughout the degree and like some of them I don't agree with and some of them I do but I do understand her view point of it. And I guess that is one of the objectives of this course anyway right trying to make me think much more of like a source of impact perspective. So I feel like the whole degree in a sense kind of gave me much more insight into the kind of real life challenges, like which I would definitely have just thought about before, if there is a challenge in terms of building a school never in a million years I would think about the impact it has to the other students and things like that (interview, Sept 13, 2018).

What was less clear was the degree to which working with engineering students helped push the social science students out of their disciplinary thinking. One of the staff members on the course seemed to think that they were not necessarily being challenged to integrate different modes of thinking and problematizing into their dissertations. In one sense, they already had the tools to deal with complex problems. "... creating that, that big map about what, what the bigger issues are ... it's something that social scientists ... they're really happy to talk about the issues and pose a question and leave it..." (interview, July 11, 2019). In another sense, however, social scientists "resist" drilling down on a solution, and this can go on indeterminately. I wondered if social scientists could have benefitted from learning more about the engineering design process, to help channel that questioning into action?

Multi-disciplinary coursework

One engineering student had experience working on multi-disciplinary projects before entering the SEM4ID programme. Reflecting on his field experience, he

recognized that he did not have the “formal knowledge” that informed the projects he worked on. The coursework in SEM4ID gave him that knowledge.

Samuel: I now have understanding of some of the things that I have really come across. Because I have studied the theoretical aspect. Like for instance I have heard of the rapid royal appraisal, we had used it before. But we were only told from a client that they want us to use it. We didn't have we have I now actually studied about what the whole concept was, but to study it in a model, I have a deeper understanding and I know how to apply it very well, so I can do that. Something about monitoring and evaluation; I had heard about it, I had been on project that was monitoring evaluation but I didn't actually understand the whole concept, to write a monitoring evaluation strategy. So now I am in the capacity to work in some of these field. And even project management I had some knowledge and a bit of hands-on experience but to do a whole module on project management it means that I am in a capacity to manage a project very well than I could do previously.

GOW: Previously okay.

Samuel: So I have learnt a lot of things than even aspect of risk analysis like [a lecturer] taught in international development. In Ghana when we were travelling to any of the locations, we don't even really assess what the happening, we just plan your staff and you go but now I know that whichever new location we want to go to you need to do a lot of reading to know the happening, to assess the level of risk, to find out whether the timing, and all that it was things that we overlooked.

GOW: Yeah.

Samuel: But now I have come to know that they are best practice. Ethical procedure like you really took me through and it's something that I wouldn't take them for granted. They were things that initially I took them for granted but now I've realised that all these things are important; ethics and all that. I didn't work with a lot of maybe ethics I thought that you could just bully your way through and get what you want, yeah but so I don't know if I'm making sense (interview, September 12, 2018).

GOW: Yeah, entirely.

Another student with an engineering design background expressed that the social science modules were the most impactful for her learning.

GOW: Were there aspects of the course – whether taught, self-directed (like reading, writing), and/or mentoring/advising – that were particularly beneficial for your time in the field?

Becky: I think certainly the social science modules, monitoring and impact evaluation. My dissertation was arguing that post-occupancy evaluation could be used in a comprehensive M&E evaluation strategy. The principles of international development, upholding dignity, accountability, and these were some of the things that were making me uncomfortable with my perceived lack of influence. Some of the guest lectures of people who worked in international development, and some of what they talked about, like having a maintenance program, came up in my research. In the field, it was clear that even though buildings had maintenance teams, they weren't sufficient to hold up the maintenance. This also came up when we were still considering building the building – we hadn't even considered a maintenance stage, and this may have been just as important as building the building itself. The social science ones were most useful.

Again, it was difficult to assess the impacts of multi-disciplinary course work for social scientists. During the same interview, Becky mentioned that there was very little taught about engineering subjects. This did not impact her, as she already had a background in her chosen technical area of study. But it left me doubtful that social science students had received enough taught engineering content in order to cultivate new ways of thinking and problem solving. I was left wondering if the benefits of enrolling social scientists and engineers together on a multi- and inter-disciplinary course flowed mainly in the direction of the engineers. During a walk with a few of the students on the Sierra Leone trip, two students with an engineering background (Cristina, Idris) and one with a social science background (Chris) discussed some of their modules.

GOW: Can you tell me about the modules that you took for this course?

Chris: OK. Like, from the beginning?

GOW: Whatever, yeah! From-

Chris: We've done a few ones for [one lecturer]. So we just started with, like, an introduction for development, which was- I enjoyed it 'cause it's what I know, though. So I don't know how you felt about it?

Cristina: Well, was, it was interesting. I never been- well, I never studied that before. So, it was quite interesting.

Chris: It was your first essay writing experience.

Cristina: Yeahhh-

Idris: Yeah, (**Cristina:** -first official one) first essay writing assignment. It definitely shook off the cobwebs.

Chris, the social scientist “enjoyed” the Introduction to Development Studies because it was familiar content for her. On the other hand, the engineering students were challenged, in part because they needed to engage in writing, which was not something they were comfortable or familiar with from their undergraduate training.

Limitations to multi-/inter-disciplinary approaches in engineering education

Course Requirements

Despite the formal processes the SEM4ID course went through to ensure quality and rigour of the academic experience many aspects of the course continued to evolve during the first year of its implementation. One aspect of the course that was a focal point of discussion was the lack of definition about the final course requirements. Halfway through the yearlong course, Andrew admitted to me that they still had not been solidified.

Andrew: ... I’m finding it hard as well because I’m still trying to evolve exactly what the, what the outcome looks like, what the projects look like. I’m really, finding it hard to, again, psychologically for me to step away from what would be the easy fix, which is just to get them to, to just give engineering, just do engineering master’s level projects... And I guess I wanted to try and work out what it was they were going to deliver (interview, March 27, 2018).

At first, it seemed that the vision for the final projects would be a cohesive group report, which would require the engineers and social scientists to work together to produce a final product. However, while students did need to submit a final group report, each student also was required to submit an individual dissertation, as well. This ultimately may have limited the degree to which students were pushed out of their disciplinary comfort zones.

By the second year, the expectations and requirements for the final individual dissertation were cemented within the SEM4ID student handbook. Though the

language within the assessment description was not restrictive, it did insinuate a social and technical divide was acceptable.

Assessment Description: Individual Technical Dissertation (Report - 30%) 8000 words max (not including cover page, declaration, appendices or references)

This component will focus on the technical and/or engagement data from the individual research project, this document is aimed at researchers and practitioners in the relevant field of expertise. It should clearly communicate:

- The background to the situation framing your research question, fully referenced against relevant literature
- The methodology adopted
- The findings, implications and impact of your research, addressing the technical and community engagement aspects.
- Appendix to include the handover documentation and ownership and maintenance plan (if required)

Students were authorized, through the dissertations requirements as outlined above, stay in their disciplinary comfort zones.

Accreditation

These course requirements were, in part, driven by the accreditation process, which, as Andrew and his co-course developers learned, would need to be different for engineering and non-engineering students for SEM4ID to qualify for accreditation from one of the major engineering professional bodies. For an engineering master's programme to be accredited, no more than 40 course credits can be allocated to "non-technical" modules. This created another structural boundary between the engineering and non-engineering students, which enabled them to remain in their disciplinary "comfort zones."

Departmental siloes

I sat in on debriefing meeting with students and staff on both of the new MSc courses – SEM4ID and ELM. Andrew and Victoria were leading the meeting and wanted to review the support structures and modules on both courses. In the first half of the meeting, SEM4ID students had the opportunity to weigh in on how the course was going for them. At one point Victoria asks the students about the level of support they are receiving from their academic supervisors on their individual research projects. She probes to see if the students feel they need additional support from advisors more experienced in international development. One student (an engineer) reports that he would benefit from more support from a supervisor with a social science background. His current formal supervisor is from the engineering department.

At that point, Andrew weighed in:

Andrew: It's easier within engineering for us to tap into that resource, because, you know, there are colleagues that we could ask. Um, we have to be careful with the other-with the social science, and we have to sort of, try to establish those initially so that we can go to them. Uhm, you know, they may do it as a favour, but I don't-I don't personally- and we don't personally know a lot of people over there. I'm not even sure if [political science staff] has-has the same relationships because of the departmental structure. But I agree, we need to move in that direction, but we need to figure out how (observation, June 14, 2018).

I started to get the sense that departmental siloes may create barriers to supporting students with their transdisciplinary projects. As Andrew mentioned in the text above, it was “easier” to work on securing student support from within the department.

The funding structures of academic departments prevent easy crossover of teaching staff from one department to another. Students pay tuition costs to specific departments based on their course of study. Staff are then allocated teaching and supervisory loads based on students enrolled within their departments. It seemed to me that if there were established mechanisms within the University that would allow for sharing of resources across departments, Andrew and Victoria were not familiar with them.

The structure of discipline-based department appears to a structural barrier to inter- and trans-disciplinarity in engineering education *globally*. According to a study which interviewed over 50 “thought leaders” in engineering education from around the world, “curricular flexibility” is inhibited due to “impenetrable departmental siloes” that make it difficult to develop integrated coursework, which benefits from knowledge from social sciences and humanities, but is tailored to the engineering context (Graham, 2018).

Disciplinary siloes

In addition to structural boundaries between departments, disciplinary boundaries persisted within the structure of the course. For instance, the marking structure for the final dissertations required two markers. Dissertations were to be marked primarily by students’ primary academic supervisors. Second markers were chosen amongst other staff members, but typically were the academic mentor for the students’ group projects. On the Zambia team, the social science student’s dissertation was supervised by one of the political science staff members who taught on the course. He would be marking her final dissertation. Her second marker would be the academic mentor from engineering who had supervised her team on their group project. This caused some degree of concern along the way, because these two academics had very different styles and were concerned about very different issues. This was discussed during a group meeting.

Alyssa: If Anders will be like, the primary marker of my dissertation, won’t he? Who will be the second marker?

Victoria: It will be-

Alyssa: Cause there’s always a second marker, isn’t there?

Victoria: It would probably be Gareth.

Andrew: I think it has to be Gareth, hasn’t it.

Chris: And then you would be mine?

Victoria: I’d be yours, yeah. Which is why I want to stay- we need to stay in touch.

Alyssa: Yeah.

Chris: Yeah, yeah.

Andrew: Second markers are by and large checking- just checking the process. There doesn't have to be...

Alyssa: It's just that Anders and Gareth would want entirely things from a dissertation. That I don't- I don't understand – [unintelligible] – how to do something, like -

Victoria: Yeah, so, we need-we need to manage that.

Andrew: Well we'll moderate. There will be a third moderator, quite possibly for these in the first instance, because they are so different, we'll have to work that out. But we'll find a way to balance it. I'm aware of your concerns, we'll find a way to balance it.

Victoria: Yeah, ok. It-It's something for us to do, not for you to worry about, I think. Because it's, um, it's about our coordination.

This high level of coordination was even challenging to achieve. As mentioned earlier, all of the academics involved in the course had many other priorities, such that it was challenging to gather them all together for meetings such as this one, where a lot of coordination about student dissertations were hashed out.

Becky: Was Gareth like, busy today that he couldn't be here?

Hari: No, he's in -

Samuel: He's travelled

Victoria: He was here yesterday, but he um, when we moved it to today, he couldn't come. He's on holiday from now.

Becky: I just think it would have been really useful for him to see, like, what everyone's doing and how the social side of things comes into it. Because, yeah, it just...

GOW: I can send along the record to Gareth and Idris, those who weren't here?

Victoria: Yeah.

Andrew: That would be savage...[unintelligible]

GOW: Then they can just hear...

Becky: Thanks.

Victoria: I take it on board, though. And we do-we see each other quite a lot, and I don't- we don't meet with Gareth, he's been really busy this year. He's got a lot of other things on, so we need to make more time to [meet with] him.

Andrew: We'll sit in and brief him on all this discussion anyway, and we'll make sure that, you know, we'll get Anders together as well, I think the four of us need to sit down and just make sure we're all exactly on the same page. Work out exactly who is going to second mark, whether they're'll be a third moderator to make sure there's a balance, that sort of thing. And then don't forget, it's also externally assessed, as well, so a lot of people scrutinize your work, particularly since it's in the first year, it will have heavy scrutiny, so don't be overly concerned that it's going to be biased one way or the other.

Becky: Yeah, no, it's more for, like, the support and my dissertation. Like, meetings with him are very like, heavy technical focused. I think for the concept of the course, you guys, obviously, 'cause you've been, from what I've seen, more involved in its development, have more of an idea of what you want and where you're going with it. Whereas Gareth is particularly engineering focused and practical focused, in part 'cause he has to deliver the summer trip, so.

Victoria: Equally, I think I should be more technical focused sometimes, you know.

Andrew: Well I'm supposed to be there to help balance that, so it'll be fine. If you - I mean, if you want to have your first meeting with him when he gets back with me present, then you know, or even Victoria as well, we can all talk it through (**Becky:** sure), it's no biggie. We'll just make arrangements.

Victoria: Fab. Um, you know, any of you can come speak to me about this. I'm sort of taking a lead on the dissertation at the minute, aren't I really, with Andrew. So if you've got questions about any of this, I'm not going anywhere this summer, I'll be here, so come and find me if you want to discuss anything, ok?

Becky: Thanks.

This meeting was just one of many group and individual meetings related to finding balance between social and technical on their projects, and between supervisory input. It was a heavy lift and a lot of staff resource to "moderate" this balance and seemed to that there wasn't an established balance in the course during that first year.

Conclusions

This chapter aimed to demonstrate the ways in which SEM4ID transcended traditional technical education in an engineering context. Instead of reproducing a banking model of education, with its conventional teacher-student dichotomies, SEM4ID opened space for student-staff partnerships, a high degree of student autonomy and a willingness of all involved to learn. This environment fostered critical thinking, deep learning, and strong, respectful relationships between students and staff alike. These dimensions and outcomes were consistent with critical pedagogy. SEM4ID also took aim at breaking down the technical siloes of traditional engineering education. It recruited students from different disciplinary backgrounds and encouraged interdisciplinary thinking through project-based teamwork. Students were further exposed to different disciplines through multi-disciplinary coursework.

These boundary-pushing approaches to engineering education did not come without their challenges and barriers, however. Though SEM4ID pushed outward the boundaries of traditional engineering education and demonstrated the potential for enacting a critical pedagogy in the engineering higher education context, the course was still shaped and influenced by the wider culture and structures in which it was steeped.

Chapter 5 - Colonial reproduction in engineering for sustainable development

Introduction

As my scepticism of the “innovativeness” of the SEM4ID course grew, it opened the door to further critical questioning. Given my past experiences working in sub-Saharan Africa and wrestling with my own “White Saviour Complex,” my sensitivities were heightened as I began to observe complex power dynamics emerge while travelling with SEM4ID students to their field sites. These thoughts, feelings, and reflections surfaced in my fieldnotes during my time with students and staff in Zambia.

We're on the road to Lusaka and it's an interesting landscape. We're on what seems like newly paved road. I've guessed the roads are put in by the Chinese but have been interested to see local labour working on the road construction. It's very industrial in this part of Zambia – it is called the Copper Belt for a reason. There are mines in the area, and you can see the heavy industry all around.

We're driving through a very dusty, possibly smoggy, part of the highway. I don't know that I've ever seen this much haze, that looks like it's from pollution, anywhere I've been in Africa so far. I've also been struck by the stark contrast between the developed roads, heavy industry, and the traditional dress and modes of transport (walking and cycling) of local peoples, as well as very basic structures people have erected to display their goods and wares, exhibited all along the roadway.

It's not the first time I've seen a sight like this, it just struck me this time as a symbol of the ongoing raping of Africa for its natural resources. I wondered how many of the valuable resources here are actually owned by local people. I imagine none, as this was one of the legacies of colonisation – the very different ways that Western people and African people considered “ownership” led to Africans losing their land to white men who believed it was their right to claim. In thinking about how this all ties to engineering, I was wondering – what if man considered the social impact of development from the get-go? Would we be living in a more equitable world, where resources were more evenly distributed? Or is industrial revolution, the way that it has occurred in the West, with all of its destruction on the environment and harm to humans [an inevitability]? Is there a smarter way? (reflection, August 13, 2018)

Reflecting on my fieldnotes, I started to wonder whether British students and Universities could do “international development” work, given the colonial past and neo-colonial present, without risking participating in those systems of oppression. I began asking critical questions, like: would change in the engineering curriculum, like that of SEM4ID, help avoid the reproduction of historic injustices? Does the engineering curriculum in the British context, however progressive, engender the capacity of staff and students to honour the struggle of historically marginalized people, particularly those who have been negatively impacted by systems and structures perpetuated by engineering?

Continuing to ask these questions as I reflected on and analysed my data surfaced deeper and more insidious forms of reproduction. Of particular concern were the ways in which SEM4ID was reproducing coloniality. In this chapter, I explore *practices* of students and staff involved with the SEM4ID programme, including the patterns of action and interaction, and draw linkages to colonial theory. Social practices, according to Nicolini (2009), involve the “sayings and doings, their temporal flow, the interactional patterns performed by the practice, the horizon of sense, intelligibility, and concern within which the practice unfolds, and the active contribution of artefacts” (p. 122). In the following sections, I analyse a set of vignettes, illustrating the “interactional patterns” that exemplified the ways in which coloniality was continuing to be reproduced within the SEM4ID course. This occurred not only in dynamics between university staff, students, and community-based partners, but also between students and staff within SEM4ID. I lean on anti-colonial theories to connect my observations to broader historical context.

Dynamics between University and community-based partners

Divisions of labour

My intensive observations with the Zambia team started on their second project trip in August of 2018. This trip involved two distinct student groups from the CoE – the SEM4ID masters students and the Zambia “expedition” undergraduate students. We were accompanied by a number of academic and administrative staff from the College, as well.

The beginning of our time in Zambia was spent in the northern part of the country, known as the Copper Belt. We were hosted by the Mutende Project Children's Village.

The Children's Village is an orphanage, which grew out of a collaboration between one Zambian-based and two UK-based churches (*A Guided Tour of Mutende - Home Page*, n.d.). There are wide ranging estimates of the number of Zambian children who have lost one or both of their parents, but between 2004-2007, the number of orphans grew from over 1.1 million to over 1.3 million. The majority of these children live with extended family or neighbours, however, approximately 1% end up in institutional care, such as the Mutende Children's Village.

We arrived on August 7th at night. It was very dark, but when we arrived, we were greeted by about 20-30 very excited children. Some were shy, some were bold. But as we disembarked from our bus, many of the children started approaching us and asking us our name. I think I was asked my name about 5-6 times by different children. Since I've spent time in children's homes in SSA before, I knew what to expect – children who largely have only been exposed to white people through “charitable mission” type work, who often come and bring gifts, treats and technology for children to play with. I also have read about how some children exposed to white charity in this way develop perverse reactions, from trauma to a certain dependency. ... because of this experience ... I did my best to avoid the children, hanging back in the shadows, moving quickly to get my bags from the bus and figuring out where I was going to stay. A number of other staff and students became more immersed with the children, fielding their questions, allowing themselves (whether they liked it or not I don't know) to have their hands held, get asked “what is your name” over and over again. We were showed to our quarters and met two women who are the “house mothers.” They do the cooking and manage the houses where the children stay. All of the students are staying in three of the rooms in one house. Some of the children and one staff person stay in this house as well and use the kitchen here (observations, August 11, 2018).

The CoE-led “expedition” had visited the Children's Village in the past. For instance, in 2017, the CoE “Zambia Expedition” took responsibility for constructing a “play structure,” that had been designed and built by engineering students (Engineering at Swansea University, 2018). In addition, they had built a sheltered area in the central courtyard, lit at night with a solar panel/battery system.

The first morning, we met ...the Deputy Manager of the Village. She welcomed us, and thanked us for coming, for “caring” and for “bringing love here.” Her introduction took about 3 minutes. Then she passed things back to Gareth, where he gave an overview of the project at hand. We came here to help build a new chicken coop. The Mutende school is expanding, and they plan to build on the site where the existing chicken coop is. By the time we arrived, trenches had been dug out. Gareth said that he expected that we wouldn’t finish the build, but that we would lay the foundation. He took us on a short tour of the grounds, explaining how they had come in years past and built a solar-powered structure, open on all sides, but provides shade, under which is now a pool table where children play, and where there are lights on at night. Then he showed us the playground that had been built in years past, as well. He told us that in addition to the chicken coop, we would be assessing the playground and fixing it up as necessary. It was clear that some of the playground was in disrepair – the rope bridge was half broken and sagging, the swings were also sagging and looked half broken (observation, August 8, 2018).

Though my scepticism about the work in Zambia had taken root before we arrived in country, it was not until we landed, and I was able to observe the dynamics between Swansea University staff and community partners that some of my concerns crystallized.

I think it was at that moment that we were assessing the playground that my first feelings of discomfort took hold – why was it that the playground was only getting fixed when we came? Was there not enough money for maintenance? Was there not a skilled person to fix it? Did people here not care to fix it? (reflection, August 8, 2018).

The disrepair of the playground was an indicator of disconnected, decontextualized, Western-led intervention. I could not image a localized approach to childcare resulting in disrepair and neglect. The concept of a playground in and of itself seemed like a foreign, imported concept.

The playground in and of itself is such a Western concept. I’ve never seen a playground in all of my travels in Africa so far (reflection, August 8, 2018).

The playground was not the only Swansea-led intervention that seemed like it was out of place. The solar-powered lighting for the shelter seemed unused.

I’ve never seen the children spending time there at night since we’ve arrived, as there are lights in the houses. There’s also a television in the house where

I'm staying and some of the Village staff and children watch it later in the evening (observation, August 11, 2018).

The whole project struck me as the importation of a Western concept of entertainment and leisure for children.

A few days later, [one staff member] had come inside after interacting with some of the children and was saying that the children seem bored, and that she wanted to figure out some way to entertain them – even this seems like a foreign concept here. Boredom is not a bad thing. ...In the West, we are raising our children to expect entertainment all the time and boredom is a bad thing... Is the playground another symbol of how we in the West believe we need to bring entertainment to children here? On the other hand, playgrounds are a great way for children to play and learn together, they have a lot of benefit and I wouldn't want to preclude African children from having this experience, and build richness in their lives. However, is the playground the best way to do it? And is having white people come build it for them without buy in and partnership the best way to have brought the concept here? (observation, August 11, 2018)

I wondered if the lack of knowledge sharing was the reason why the playground had been left to disrepair. Had the CoE stakeholders who did the initial construction involved local labour?

In another building project, the organisation of labour appeared to be completely divided. As mentioned in an earlier vignette, the Mutende Children's Village was planning the construction of a new chicken coop, to replace the one that would be lost due to expansion of their school building. When we arrived, the ground had already been dug and the foundation had begun to be laid. This was all achieved by local labour. In the first days of our time there, however, our group was left to our own devices to continue working on the build. It was if local labour had tagged out, and the CoE group had tagged in – we operated separately from one another. This seemed like a missed opportunity for knowledge sharing and building connections. Furthermore, it felt somewhat irresponsible for our group to take over construction without local guidance and expertise - few staff or students from SU had experience with manual labour or construction projects. In fact, I came to find out that after a few days of laying blocks to build the walls of the new chicken coop, the local labourers needed to be brought back in to take them down and re-lay the blocks, since they had been laid improperly and resulted in an unstable structure.

It made me wonder about the use of resource. A great deal of money had been spent to fly students and staff to Zambia, only to build walls that needed to be re-built by local experts, with little emphasis on culture or knowledge sharing. Would the money on transporting us all down have been better spent on a direct investment with the Children's Village to pay local labour for the construction work? Could the expenditure have been more impactfully and meaningfully used had there been more intentional cultural and knowledge sharing?

In considering why this separation between SU staff and students and local labour existed, I came across Walter Rodney's polemic, "How Europe Underdeveloped Africa." In it, he argues that the process of colonisation established an *international division of labour*.

"...up to that point [the expansion of European colonisation], each society had allocated to its own members particular functions in production – some hunted, some made clothes, some built houses, etc. But with colonialism, the capitalists determined what types of labour the workers should carry on in the world at large. Africans were to dig minerals out of the sub-soil, grow agricultural crops, collect natural products and perform a number of other odds and ends such as bicycle repairing. Inside of Europe, North America and Japan, workers would refine the minerals and the raw materials and make the bicycles ...It was the American, Canadian, British and French workers who had access to the skills involved in working with ..." the vast natural resources that Africans extracted from the ground (Rodney, 1973, p. 194).

Rodney goes on to argue that the international division of labour established during the early decades of colonisation persist today.

I started to wonder if this division of labour contributed to the normalisation and perpetuation of separation; a certain hierarchy between colonial and metropolitan labour, such that, when the CoE group engaged in building a chicken coop, they did not even consider integrating or knowledge sharing. On the other hand, maybe in toiling on the chicken coop, the CoE group's attempts to contribute to the hard labour of building such a structure were an effort to challenge the status quo of this division. By picking up shovels, laying bricks, and engaging in manual labour, they were demonstrating that metropolitan workers can cross lines of colonial labour divisions.

However, it was unclear that CoE staff and students were crossing these lines consciously, in order to break down the boundaries between divisions. Are there benefits of resistance when it is not intentional? Do singular acts of unintended resistance potentially have positive impact?

I got the sense that in this case, the separation between CoE students and staff, and the local labourers followed in the lines of normalised colonial labour division. Despite the fact that they were using their bodies to toil, the CoE group upheld the division through their self-seclusion.

I gained insight into the way that the local labourers viewed the CoE group through one of the masters' students, who seemed to have formed bridges between the local labour and the CoE group. During a debrief with him, he described to me how he built relationships with the local labour. He felt that he had integrated well enough that the labourers felt comfortable joking with him about the rest of the CoE group.

Hari: ... up north I felt like I integrated much more than the other people in the group just because I made an effort to actually go to the other side and be like oh do you need any help.

GOW: Yeah.

Hari: Literally just as simple as that and like they were talking to me and making jokes about like the other guys working on the other side and things like that.

GOW: Who was making jokes with you?

Hari: Like the locals.

GOW: We're making jokes with you? About the rest of the under grads and stuff?

Hari: Things like every time, they were putting things in the cement mixer they would always point to their muscles and be like African man powered by a machine and African man wins and things like when people are just standing around flabbergasted and they would point and laugh at them and do this and point and laugh at them and things like that and also like after the trip they would come and fist pump me but just ignore the other guys.

GOW: The under grads would come in and fist pump the...

Hari: No

GOW: Oh the locals would fist pump with you

Hari: But not with the other guys

GOW: Or the rest of the Westerners.

From this account, I sensed that the local Zambian labourers were also upholding the division of labour, whether consciously or subconsciously. Their jokes indicated they were confident in their abilities to do hard labour. In mocking the students and staff, the labourers showed recognition of how unnatural that type of labour seemed for the CoE group, compared with themselves.

The relationship that Hari was able to bridge between the CoE group and local labourers indicated that a different dynamic was possible. If there had been some dialogue fostered between the CoE group and the local labourers, there may have been an opportunity for an intentional crossing of division lines. Perhaps, through dialogue and collaboration, there may have been the chance for this group to break down those colonial labour divisions. Though this alternative path may not have challenged the economic structures that uphold those divisions, they may have challenged the mental models of who does what form of labour in a globalised labour market. The apparent lack of effort, particularly on the part of CoE staff and students (with a few exceptions), seemed like a missed opportunity.

Missed opportunities for connection

The second half of the Zambia trip was spent in Siavonga. After spending a few days in the area, I had a chance to deepen my understanding of the history between Swansea and Siavonga by talking with some of the SEM4ID students, as well as G, one of their primary local contacts.

After [a group meeting], we went back to our rooms to get ready and then headed for the bus that would take us across town to Siavonga Primary School. While we were lingering, waiting to get on the bus, I asked Hari to introduce me to G [after] I overheard G telling [a staff person] about the various partnerships that Swansea has with Siavonga, including partnerships with Morrision and Singleton Hospitals (observation, August 14, 2018).

Until that point, I had not heard the Zambia team, or their academic supervisors involved in the trip, talk about these relationships. Given the long standing and formal connections between Swansea and Siavonga, I was surprised that the CoE-led activities did not seem to build on that relationship.

I asked Hari about that and he said they (the students) didn't connect with any institutions in Swansea that have existing relationships here. He seemed a little baffled that they didn't (as baffled as I was upon hearing all of this information) (observation, August 14, 2018).

During a debrief with one of the MSc students about her perception of CoE-Siavonga community relations, she reflected on the relationship between the SEM4ID students and the Nutrition Group.

Becky: I feel like, with the Discovery charity, they had an existing relationship, and the folks at the Nutrition Group, in the past, they were really enthusiastic, but in relation to our group, did not see the same enthusiasm. There wasn't one person managing the relationship. During our trip, we didn't have a formal goodbye. Even [a main stakeholder] pulled a 'sicky' on the last day. We could have done better, I could have done better (interview, October 4, 2018).

She went on to consider how perceptions of the various groups coming from Swansea may have been perceived by Siavonga stakeholders.

Becky: We went with the summer expedition, and to have those two groups at the same time representing Swansea University, it was difficult to distinguish how we were different from the undergrad group to our stakeholders, including what the relationship would be with the school. The undergrad group was delivering a practical solution, where we wouldn't be delivering that. It made it tough to figure out our relationship. Discovery is also perceived as from Swansea University, but through all of this there wasn't a hand-off or collaboration. To the local Zambia stakeholders, I think they perceive all Swansea University groups as one, when we are really going out doing separate things (interview, October 4, 2018).

The souring of relations between the CoE students/staff and Siavonga stakeholders may have suffered due to the ways the CoE group organised themselves, exacerbated by the physical distance between us. Originally, staff had organised a guest house for the students to stay in, which was located within walking distance of the field site. There was not adequate space in the guesthouse for all students and staff, so the staff

and doctoral students on the trip (myself included) were booked into a local hotel, which was across town. After their first night in the guest house, however, some of the students reported feeling uncomfortable and unsafe at the guest house accommodation, so a decision was made to relocate all of the students to the hotel, as well. In staying at the hotel, students came back “under the wing” of staff. Instead of students having the opportunity to organise themselves, walking themselves to the field site, having space to interact with local stakeholders, potentially go to the nearby market to have meals with partners, and other possibilities for culture sharing, staff had a heavier hand in organising the students’ time and movements. It was staff who organised a bus to transport students across town to the field site, and who determined the timings of comings and goings. In terms of meals, staff also determined that everyone would eat at the hotel. So each day, we would have our breakfast together at the hotel, bus to the field site, return back to the hotel for lunch, bus back to the field site for the afternoon and return to the hotel for dinner. One student reflected on how this division impacted the ability to integrate with local stakeholders.

GOW: So you have kind of talked about some of the challenges of the trip. Were there any other particular challenges that you came across?

Hari: In terms of technical challenges no but in terms of social challenge in itself, I think I have talked to you about this before but just the perception of what we are doing...I guess this is more of a stereotypical charity work in like we stayed in a hotel. It was the nicest place I ever stayed at, right, which was about 15 minutes’ drive from the School and then one thing was, every day we went back to the [hotel] for lunch, right, even though the market is right there and it kind of I guess... maybe it might be because there were a lot of under graduates who had been there for the first time or who haven’t been exposed to the African community or a poorer community for the first time and that was the case with a few that I talked with right so it is just like not a class system but like a different divide in terms of, we go stay in this nice hotel, we work for a certain number of hours and then you guys do this, so it is kind of like we are [too] good to eat at the market in a sense, so that in the long term was just ruining what we were trying to achieve which was to integrate with the locals and actually work together with the locals rather than working for them and that was kind of evident, up north as well...(interview, September 13, 2018).

Another SEM4ID student reflected about how culture sharing may have helped bridge some of the divides.

Becky: ...it was challenging being in a new culture that I didn't really understand. It was challenging particularly because I didn't feel like...it felt like we were the ones that stuff was orienting around, instead of us being involved in local culture. For instance, if we were cooking with Zambian people in the evening, seeing what they do a little more, we may have built more of a connection. Like the last time, we invited people for a meal, it was nice to spend time with them, hang out with them, experience a bit more of their culture, and it helped break down that cultural barrier. However, it would've been good to have experienced dinner at their place, too, as more of an exchange (interview, October 4, 2018).

I had an opportunity to interview the Nutrition Group representative who pulled a 'sicky' on their last day of the trip. He reflected similarly on the importance of culture sharing to build bridges. He described the differences in how the engineering students/staff interact, compared with the Discovery volunteers.

G: What I have ... noticed between the two groups the Discovery Team when they come, they come as a team, they cook as a team eat as a team, the engineers when they come you stay in the hotel ... then each and everyone will choose what to eat and what not to eat (interview, August 15, 2018).

Culture sharing practices, including eating together, can act as powerful mechanisms to challenge colonial power relations between colonized and colonizer.

Colonized/colonizer power relations are characterised by difference – social, ethnic, linguistic, class and, importantly, racial. Racialized difference was not new during the colonial era – constructions of race have been traced as far back as ancient Greece and Rome. European colonizers, however, used racial stereotypes as “ideological justification for different kinds of exploitation” (Lomba, 2002, p. 113). Ideological racial difference “intensified” through the growth of “scientific” theories of race. These pseudo-scientific theories advanced the notion that race was “biologically-constituted” and attributed “racial characteristics to biological differences such as skill and brain sizes...facial angles...or genes” (p. 117) Through the insistence “on the connection between these factors and social and cultural attributes, science turned ‘savagery’ and ‘civilization’ into fixed and permanent

conditions” (p. 117). Colonisation was a dehumanizing process; as Fanon describes, “it turns him [the native] into an animal” (Fanon, 1963, p. 42).

Sharing food involves physical processes – the physical contact amongst diners, when passing dishes around the table, grazing a neighbour’s arm while bringing food to one’s mouth, clinking glasses in a toast – and mental/emotional experience – conversing, managing silences, approaching unfamiliar customs around use of hands and/or utensils while eating, and/or encountering unfamiliar flavours. The closeness and encounters with the unfamiliar of shared meals challenge notions of “otherness” in an intimate setting, while taking part in a universal human activity. Sharing meals across cultures, while is by no means a universalizing or equalizing force, does create opportunities for connection and re-humanization. The Zambia team, again, with some exceptions, seemed to miss out on these opportunities.

Marginalisation of “diverse” knowledges

The devaluing of the “other” and their knowledges was foundational in the construction of power relations between colonized and colonizer. “African cultures were considered by almost all nineteenth-century European observers to be devoid of scientific thinking and all but the most primitive technology. This assessment became...central to efforts to demonstrate the validity of the long-standing view of the Africans as backwards and inferior peoples” (Adas, 2015, p. 153).

These attitudes have been largely left unchecked. Coloniality lives and breathes through our subconsciousness. This tendency is so insidious, it is normalised within our daily interactions, such that even the most progressive and committed adherents to “making the world a better place” can fall into this trap.

One student in the SEM4ID programme consistently showed dedication to their studies, leading to the construction of a strong research project, which made up their dissertation. Throughout the months I interacted with this student, I often found myself noting how “detailed,” “in-depth,” and “well-planned” their project was, and how much further they had advanced their work, compared to the other students on the course. This student had previous experience in engineering and in socio-technical research, so brought maturity and perspective to their studies.

Despite the high standard of their work, I noticed that some of their academic advisors seemed unsure that they would be able to achieve their ambitious project aims.

Victoria: So you're looking really at processes of tender, evaluation processes and how organisations... Are you looking for private organisations, public organizations?

Samuel: Both private and public. Both private and public, so including the government agencies, ministries and departments in the various districts...

Victoria: So have you got the information about how they currently assess bids, then?

Samuel: Yeah, I want to find out that ...I know that normally the tender process, from the scoping trip gave us a gist of how they do it. They look at the qualification, the pre-qualification, then the evaluation and the criteria. But I want to find out whether there are some social considerations, like stakeholders, engagement plan or communication plan. How they hope to engage with the community, how they hope to tap, the contribute to the local economy, for instance, and the traditional way of procurement normally look at the lowest bidder and the lowest normally concerned with the capital cost of the project. So things like the operation costs, and other kind of, are not factored. But if we really want to achieve sustainability target, then you should look at the life cycle costs...

Victoria: I think it's interesting. So your biggest challenge is going to be the fact you're working in a resource constrained society, when the lowest cost bidder ... is going to be the most attractive. ... But you'd need – you need to evidence it....

Samuel: Yeah, I need evidence. And I want to find out whether there has been a case where the lowest bidder was not given the project because somebody else was looking at the social consideration, environmental consideration, that well, if you give him the contract. I want to look at some environmental issues and whilst I'm achieving the technical aspects, I also want to balance the social and economic aspect of that....

Victoria: Are you confident that you'll be able to get the current tender procedures that are used? Sometimes these documents are quite tightly controlled...

Samuel: I'm not going to look out for the document... it would have been good to get it, but it's going to be difficult from the way I see it. So I'm using a quantitative and qualitative [assessment] from the literature that I've

read...and comparing with the Zambian government guidelines. I'm looking out for some indicators for each of the dimensions of sustainability that can be considered in the procurement stage.

Victoria: There's a lot in there, that's my concern. There's really a lot in there.

Samuel: Yeah, but like I'm working on it and I think I can achieve it.

Andrew: That would give you a massive policy document. It's [an] enormous piece of work. I do agree with that. How you target, I don't know that.

Victoria: Yeah. The topic is good. But it's making sure you get the evidence behind it. And making sure what you're doing fits well into what's there already are the big things for you, but it sounds good.

Andrew: You won't be able to make assumptions that you'll need.

Victoria: No, yeah. It's got good potential. But it just depends on what information you can get, so keep an open mind...(observation, July 10, 2018).

This questioning of the student's ambitions continued, and at a certain point, I stepped in, to try to reiterate what Samuel was trying to do, thinking that adding my voice might help back him up. I was familiar with his project aims and scope; we had met just prior to this meeting. He had walked me through his project, and we talked through some of his concerns on his methodology. To a certain extent, I agreed with Andrew and Victoria that the scope of the project was large, that said, after talking with him, he convinced me that he had thoroughly considered how to accomplish this scope within the timescale he had.

GOW: So, we just met and went over the tool that [Samuel]'s been developing and ... the information you're going for, is more of the review. So, you've developed a survey tool and a few qualitative questions to kind of expand on some of the quantitative or quantitative data. But asking about perception, about knowledge, challenge, opportunity, along the lines of the sustainability criteria, and you've pulled from the literature the different dimensions of sustainability along with social, economic, and environmental...

Victoria: Is there a way of finding the procurement managers, as well?

Samuel: Yeah, I have already had a response today from Siavonga. I think the guy I had spoken to, the organizations around, we are left with the contractors, but with the government agencies, they are all willing, and he's asked me to give my work plan (**Victoria:** That's brilliant) so that I book appointments and can engage with them. Yeah, in the North-

Victoria: That's fab. That's-that's the level you need to go to for what you're trying to do.

Samuel: Yeah, and then in the North too, [another student] gave me a contact person and he also snowball and gave me another person, and apparently, he's ready to help and I've also asked him to find out organisations, how I can book appointment on various days. Yeah, but he is ready to support me in the days that I will be around.

Victoria: Good. (observation, July 10, 2018).

I reflected on this interaction afterward.

Samuel had prepared for this. Why weren't teachers as sure that he could achieve it? Was it just based on the sheer scope of the proposal? Or was there doubt that they could achieve it? If there was anyone in the course who could, it would probably have been them – they already had industrial and research experience, they have experience in “developing” countries, so has better understanding of how to interact/navigate people and systems. So where was the concern about the scope coming from on the part of Andrew and Victoria? (reflection, July 10, 2018).

Even though I thought highly of this student, I also sometimes experienced doubt in his abilities. I return to an earlier vignette to illustrate one such moment.

Samuel called him but couldn't get through. We ended up loitering for a few minutes in front of the Civic Centre, half just to chat and debrief, half to wait to see if Mr C would call Samuel back. As we were about to give up, Mr. C came down the path toward the Civic Centre. Samuel was eager to get in another interview/ questionnaire before breaking for lunch. Mr C smirked and chuckled – I got the impression he was amused by Samuel's ambition, but also was a bit patronizing, or maybe he had lost interest in putting a lot more effort into making arrangements for us. I got that hint, but Samuel pushed more to see if he could meet with anyone who does procurement in any other ministries, including health, education. I wasn't sure at that point whether Samuel was getting the hint as well and pushing regardless, or he didn't see that Mr C was losing interest. In the end, Mr C offered to see if the

building inspector was available, but that was the only other person he was able to make arrangements with (observation, August 9, 2018)

When I first noticed Mr C patronizing Samuel, I was not sure if he picked up on it. When I asked him later that day, if they noticed that Mr. C was trying to move on with his day, and he told me they were aware of it, but decided to be assertive anyway, because though Mr. C seemed somewhat interested in helping him, he knew that he was also busy with his work. Not only was he aware of the nuances of the social interaction, but he also knew how to move through difficult interactions to get what he needed. So why did I doubt him?

This subtle hint of doubt was not the only way that some involved with the course expressed themselves to this student. There was also a lack of acknowledgement or a certain blindness to his existence.

In a group meeting earlier that year, lecturers had asked students what additional resources or lectures they would have liked to support their field work. One student suggested that they wanted to hear from an engineer or social scientist who has worked in the “developing world.” I found this strange, as Samuel had a background in engineering and was from a “developing nation” and had experience working in these settings. I came to learn that the students did interact with one another quite often; they had a private WhatsApp group, and met independently of staff to work on their projects, troubleshoot and brainstorm. It is possible that Luke had met and learned a lot from Samuel during the course of the academic year. However, in that moment, it felt like an erasure of Samuel’s presence and experience.

I noticed other instances of a certain dismissiveness of this students’ experience and knowledge of how to navigate field work. During a team meeting, one academic supervisor pushed for an approach that was ultimately inappropriate for the setting. It became clear to me that Samuel was aware how this approach was inappropriate, but he deferred to his supervisor.

Gareth arrived [to our conference room] and right away was asking students about their plan for their trip. Hari informed him that they don’t have one yet. Samuel joined approximately 10 minutes late. He had more information about the conversation about whether they are going to another village

(between Mutende and Siavonga). MS seems frustrated that plans haven't been made yet for the trip, [but from what I've observed], Samuel seems hot on the trail with on the partners and was responding to Gareth with details about how he has been working to make connections and plan. When Gareth was hammering about the [lack of a] plan, Hari smiled and nodded, but didn't say anything. [I recognized] that Gareth is coordinating among 19 people, which will be splitting into 3 groups at different points in the trip. [These complicated logistics did seem like] a rationale for why he is hammering them on the project plan and their logistics (observation July 9, 2018).

Though he had complicated trip logistics to take into account, the insistence on having a detailed plan for field work seemed inconsistent with the way that field work is usually conducted in sub-Saharan Africa. While we were in Zambia, I asked Samuel if the way our work has been going today (the impromptu nature) is typical where he is from, as well, and he said yes, that was correct – his meetings back home are often planned on the go (observation, August 9, 2018).

During a debrief with this student, he further demonstrated knowledge about African working culture.

GOW: Can I bring up something that were just talking about like timing and setting meetings. I'm curious so you had mentioned earlier today that the way that you [have] work[ed] was that you don't set up formal meeting times that that's not part of the process of having meetings and working together. Can you kind of tell me a little bit more about how that came about?

Samuel: Ok ... to put it into perspective, what I was actually talking about was even though some organisation...for some people, they want formal appointments booked because they might be so busy, but the majority of the people be it formal organisations it is not a bit of a hassle if you are not able to make any appointment. You just walk in and you show some formal documentation I'm coming from this organisation may I have your attention they can tell you ok this time I'm busy, can we make it maybe 2pm. So you don't have to necessarily book or sometimes you just talk to them and instantly they will just do it for you.

GOW: Yeah.

Samuel: So, I think that came up when I wanted to get the appointments confirmed. Some of the contact persons no matter how many times I kept reminding them to get me a confirmed appointment, they said don't worry

when you come you don't necessarily have to do all this when you come we will just take you through. People are ready to take part.

GOW: Okay.

Samuel: And [Gareth] also didn't want the situation where you get there and you don't do anything ... but ...in particular in Siavonga, I had all the appointments confirmed, but in the Northern the Copperbelt province, they were not really confirmed. They told me that once you come you will do it and I realised that it's something that has to do with us Africans the way we see time is different from over here, because here people particularly every hour is paid for so then there is value for time. Time is money, it makes sense in Europe, but not in Africa because you're paid at the end of the month so sometimes you might only be productive in just one week, but at the end of the day they are paying you for the entire month, so people feel like they have a lot of time so then they can talk to you ... that was what manifested in my planning...those people are all around and so far as you come we can just talk to them ... (interview, September 12, 2018).

This student was not the only one who seemed to struggle to be heard.

Early in my relationship with Idris, I learned he felt stunted in his ability to contribute and influence his team, that he couldn't "get through" to them.

During a conversation we were having about the artist and public figure, Akala, Idris told me that he admired how well he is able to articulate his ideas and perspectives. He told me that he has been struggling with that and that he aspires to be able to articulate himself as clearly as Akala. He told me for instance, even within SEM4ID, he feels like he will say something, and people will react strongly, so he feels like he has said something wrong. Though, he also acknowledged that he felt like others needed to "do the work now," which, though he did not explain what that meant, I'd assumed meant the internal work to check and undo their implicit biases. He is black and his peers are white (observation, June 5, 2018).

I was not present in those early meetings that he was referring to, but I did notice that Idris rarely attended whole group meetings and would often be the only student in the SEM4ID cohort to be absent. He even asked me to represent him at one concept development meeting that he was unsure he would attend (July 10, 2018). Meetings were not mandatory, but encouraged, and it is possible that Idris had other obligations. Yet I could not help but wonder if he avoided the group because he did not feel valued or heard in those conversations.

I noticed Idris's proposed technical design for Home Leone's water purification system was quickly and easily dismissed by J, the British manager of the Home Leone site. Idris had been planning an in-line filter system, using local materials for the filtrate. He had gotten to the stage where he was looking for materials to build a prototype during his second field visit. He was working closely with M, the lead plumber on site to develop this prototype. One day, I travelled with Idris and M to a local market to shop for the pieces needed to build the prototype. When we returned to Home Leone after that trip, the three of us had a quick meeting with J (the manager of Home Leone), who, within about a 5-minute check in, told Idris that he did not want the in-line filter, and instead wanted a large drum filter that would be dug into the ground. They would make 1 "in ground" filter per villa. In one fell swoop, Idris's in-line filter project was dead.

After that meeting, I walked with Idris out to an area where he was developing his filtrate materials.

Idris, while we were out in the back of the volunteer women's cooking station, was talking with me and Luke and said he was "gutted" about the in-line filters, was a more interesting engineering project, but will still write something up (observation, June 7, 2018).

In a group meeting a few days later, Idris was reporting this update to his peers.

Idris: So, I'm still proceeding with the water filters but, it feels like more of a contractor sort of for J. He's got his sort of spec and the way he wants things done, so initially I wanted to produce an in-land water filter with McCarthy, and one of his guys from his team was sort of like asked to lead engineers on it coming together for an idea to [unclear] the filter. J said no, he wants the land excavated, he wants it drum, drum goes in the ground so make the filter out of that, which is all fine you know what I mean? McCarthy said to me I'm still learning a lot and that I've never done anything like that before, so there's still a sharing of expertise. But J's sorta pledged one guy from his plumbing team as well, sort of help us put it together and to design it (observation, June 9, 2018).

During an interview with Idris the next day, I asked him more about this.

GOW: You had mentioned, uh, the other day, when the project shifted from inline filters to the in-ground? I think you said you were gutted...

Idris: I was. And it's this whole balance, you know, between bringing value and then putting my own spin or adding my two pence to it, do you know what I mean? Like, J did mention before the whole idea of barrels in the ground. I think I mentioned this to you.

GOW: Yeah, you did.

Idris: But you know, to me, it was just thinking out loud, it wasn't something he had committed to, so I thought ... when it comes to filters nowadays, like, less is kind of more the way that trends are from my experience. So I thought a minimalist filter that doesn't require a lot of, you know, ground work, it doesn't require a lot of maintenance, it just does its job and it's just easy to just change it, clean it, whatever, you know, less is more. So I thought, let me run with that, but then in conversation with J, he kind of confirmed, that yeah, [he] still want[ed] the in the ground drum filters. Which I was gutted because it didn't seem like much of a challenge for me, but that's -I guess that's not the point, the point is that it has to be easy for the people moving in to use, maintain, understand and, you know, working with McCarthy, who is the head of plumbing, and this ... apprentice that we're going to have, like filtration is relatively new to them anyway. So maybe the minimalist approach is a bit complicated for them and it would be a bit complicated for people moving in.... So you know, I was gutted at first, but after you know, letting it-let it set in, sort of, you know, mellowed in it for a little bit, drew my own conclusions and then, sort of, let it go and just get on with it now sort of thing (interview, June 10, 2018).

He continued this line of thinking. Though I believed that the end user (i.e. the manager and staff of Home Leone) are the ones who need to be happy with the final product, in this case, it struck me that J had missed an opportunity to hear from someone with previous experience and expertise in water filtration. The way that Idris was talking about the final design struck me as though he was rationalising J's dismissal of his ideas.

Conclusions

It may be impossible to disentangle the contribution of race, coloniality and engineering ways of knowing and being amongst these examples, because they are historically intertwined. The aim of this chapter was not to disentangle those issues, but was, more importantly, to acknowledging their intertwined-ness. Though I did observe some students and staff, me included, wrestling with their positionality within colonial structures of power, what closer observation helped reveal was that

there is often, if not always, a blindness to the ways in which oppressive systems live on within the daily practices and interactional patterns of our lives. These practices are so subtle and normalised, that they most often go unnoticed and unchallenged. For those of us who benefit from whiteness and Western birth and citizenship, recognising the ways that we contribute to the marginalisation of people of colour and/or people with different ways of being and knowing from ourselves, and experimenting with new patterns of interaction, is essential praxis for interrupting colonial practices.

Chapter 6 - Discourses

Introduction

In the following chapter, I continue my reflexive analysis, but I turn my focus from practices and to discourse. In ethnography, identifying discourses through observed language acts serves as an important way of uncovering symbolic meaning. The degree to which ethnographers use and analyse discourses varies, however. In critical ethnography, this work can serve an important function in helping draw connections between micro level empirical data and macro level social and cultural conditions (Carspecken, 2013; C. A. Davies, 2012).

Discourse is a social process related to the way we use language. It is more than the exchange of content in a conversation, or the grammatical systems of syntax and morphology that make up common language. Rather, understanding language use as discourse acknowledges the impact that language has in shaping our world. Discourse allows us to know things, “to do things” and “to be things” (Gee, 2004, p. 2). Fairclough (1992) describes discourse as “a practice not just of representing the world, but of signifying the world, constituting and constructing the world in meaning” (p. 64).

Foucault is credited with showing how discourse analysis can be used to deepen our understanding of the mechanisms of power in society. Using genealogical discourse analysis, Foucault extends the work of Barnes, Parsons, and Arendt, to demonstrate that power works, not through top-down hierarchies, but through agents. Foucault illustrates how “power...extends itself in a capillary fashion – it is part of daily action, speech and everyday life” (Loomba, 2002, p. 50). His work helps show how discourse and structure are mutually constitutive, how discourses shape and are shaped by, constrain, and are constrained by structure. Fairclough (1992) elaborates: “discourse contributes to the constitution of all those dimensions of social structure which directly or indirectly shape and constrain it: its own norms and conventions, as well as the relations, identities and institutions which lie behind them.” (p. 64). In short, analysing discourse can help surface and understand social structures and the mechanisms and relations of power that shape and uphold it.

Discourse also illuminates the dynamic relationship between structure and agency. Just as discourse “contributes to reproducing society (social identities, social relationships, systems of knowledge and belief),” or social structures, it can also contribute “to transforming society” (Fairclough, 1992, p. 65). This conceptualisation is important for educational studies. According to Fairclough (1992), “the identities of teachers and pupils and the relationships between them which are at the heart of a system of education depend on a consistency and durability of patterns of speech within and around those relationships for reproduction” (p. 65). However, this is also fertile ground for “transformations which may partly originate in discourse: in the speech of the classroom, the playground, the staffroom, educational debate, and so forth” (Fairclough, 1992, p. 65).

Foucauldian discourse analysis has also become a critical tool for studying coloniality.

“Discourse analysis...makes it possible to trace connections between the visible and the hidden, the dominant and the marginalised, ideas and institutions. It allows us to see how power works through language, literature, culture and the institutions which regulate our daily lives” (Lomba, 2002, p. 47).

In the current study, there were many incidences throughout my fieldwork where I observed uses of terminology that appeared to uphold colonising representations of relations between British and sub-Saharan African nations. In the following chapter, I use my observations of language acts and connect with established theory on colonial discourses to draw some tentative conclusions about the ways in which participants contributed to the reproduction of colonial relations. I draw on Escobar’s analysis of development “as a regime of representation” that has established and maintained Western conceptions of developed vs. developing and First vs. Third World. (Escobar, 2011, p. 6). I aim to highlight how “stereotypes, images, and ‘knowledge’ of colonial subjects and cultures tie in with institutions of economic, administrative...control” (Lomba, 2002, p. 54). I do so by drawing connections between the structure and content of SEM4ID, the ways in which students, staff, and community partners relate to one another, and the discourses of development and coloniality.

Colonial language acts observed

Supremacy of imperialistic capitalism through development discourses

The terms “sustainable development” and “international development” have become commonplace across Western higher education institutions. Their inclusion in the names of courses of study, volunteer abroad excursions, and student societies signal opportunities for students to “do good” and to “help.” Alexander (2012) contends, however, that terms like sustainable development have become “potent but empty rallying cr[ies], laden with positive value but so variable in content that [they are] almost devoid of meaning, other than being a Good Thing” (p. 456). In an engineering context, these terms, especially sustainability and sustainable development, have come to mean something about the environment, but rarely connect to issues of society. Taken further, by applying an anti-colonial lens, we can start to see that “sustainable” or “international development” may not just be innocuous “good things,” but may have more insidious, colonial roots.

In *Encountering Development*, Arturo Escobar applied discourse analysis to the concept of “development” within the context of colonisation. He uses discourse analysis to “singl[e] out ‘development’ as an encompassing cultural space and at the same time separat[e] ourselves from it by perceiving it in a totally new form” (Escobar, 2011, p. 6). In doing so, he illustrates how “development has relied exclusively on one knowledge system, namely, the modern Western one” and shows how “the dominance of this knowledge system has dictated the marginalization and disqualification of non-Western knowledge systems” (p. 13).

Most telling of how the concept of “development” is used as a tool for maintaining colonial power relations is the story of how the term has been applied in the post war era. Though the concept of development is not new, the way that “sustainable development” and “international development” are used today emerged in the mid-1900s. During this time, a group of “so-called modern states (primarily Western European [countries] and the United States, and later Canada and Japan) created institutions (such as the International Development Association and UNESCO)” and convened panels of “experts” to “learn about, support, and improve life...in so-called developing states” (Kendall, 2009). An effect of this process was

the construction of a new underclass of people in newly independent nations of the global south – “the poor” (Escobar, 2011; Kendall, 2009). Prior to this, the poverty of “natives” was not a great concern of colonizing nations. The general belief was that “even if the ‘natives’ could be somewhat enlightened by the presence of the colonizer, not much could be done about their poverty because their economic development was pointless. The natives’ capacity for science and technology, the basis for economic progress was seen as nil” (Escobar, 2011, p. 22).

The change in the Western conception of poverty “occurred...first with the emergence of capitalism in Europe and subsequently with the advent of development in the Third World.” The invention of Third World poverty came the notion that “the poor” were “a social problem requiring new ways of intervention in society” (Escobar, 2011, p. 22). This new social problem required mechanisms and indicators of progress, which have been set by Western development institutions, and have largely focused on economic measures, such as Gross Domestic Product (GDP) per capita, job creation and growth, and access to modern technology, such as hospitals or electricity (Kendall, 2009).

Though there have been many challenges to this econo-centric position, none have been powerful enough to shift the discourse of development beyond it or consider what alternative indicators of human progress could be. “The relative stability of the term ‘development’ reflects continued general agreement amongst powerful actors and institutions around the world on the shape and scope of the international development arena” (Kendall, 2009, p. 420).

Western higher education institutions are embedded within these global power relations and are part of the mechanisms that reproduce them. It was during the formation of institutions like UNESCO that concerns about the development of the Global South became salient to the field of education. UNESCO itself took up the mantle of education for development with the organisation of regional education meetings. There was a concurrent rise in other education-related professional bodies and institutions, including the US-based Comparative Education Society (Kendall, 2009). Over the past 70 years since, Western institutions of higher education have increasingly focused attention on developing pedagogy and conducting research related to the “problem” of “the poor” in the “Third World.”

Engineers have also been involved in development interventions since the inception of Western development institutions. Naturally, the transfer of technology, a key component of colonial and neo-colonial strategy and discourses, has relied on engineers' involvement. However, from the colonial to the neo-colonial era, ideologies around "natives'" need for science and technology morphed. From the belief that Africans were devoid of scientific thinking and technology, emerged the creation of the concept of the "Third World" and the necessity of its development. "In 1948, a well-known UN official expressed this ... in the following way: 'I still think that human progress depends on the development and application of the greatest possible extent of scientific research. . . . The development of a country depends primarily on a material factor: first, the knowledge, and then the exploitation of all its natural resources'" (Escobar, 2011, p. 35).

Though engineers have been involved in the practices and discourses of development for centuries, "they never scaled up to make inroads in ... engineering education or in the mainstream professional conduct of engineers until [recently]" (Schneider et al., 2009, p. 44). This shift has occurred, in part, as engineering interventions in the "Third World" focused on providing technical assistance and "appropriate technologies" to "communities" (p. 44). As discussed in Chapter 1, "engineering to help" initiatives have made an appearance in Western higher education institutions, through organisations like Engineers Without Borders and Engineers for a Sustainable World (Schneider et al., 2009). There has been a concurrent increase in the number of programmes and courses of study in engineering higher education institutions.

Sustainable Engineering Management for *International Development* is one such example. The title of the course came in part, from Andrew. In an interview, he described his view of "international development:"

GOW: ... can you describe what international development means...?

Andrew: Well, I guess ... my consideration is around the development of countries that are... what have classically been classed as developing countries, or third world countries, and looking at their development both socially, economically, and environmentally. And I guess it's as simple as that to be honest (interview, March 27, 2018).

The inclusion of “sustainable” and “international development” in SEM4ID, however, involved additional dimensions of power and politics than a typical university course, where the name is generated independently, in-house. As previously mentioned, the launch of SEM4ID came with support from the Prince’s Foundation. Charles III, the (then) Prince of Wales himself endorsed the programme, and with a “hand shakey, shakey,” asserted power over the formation of the course, the projects students would be focusing on, and the name of the course itself. The terminology “sustainable” and “international development” were important to the Prince’s Foundation to include in the name of the course, and so they were.

The Prince’s Foundation is another institution with links to the British imperialist regime through its directorship by members of the British royal family. According to its website, the Prince’s Foundation is dedicated to “realising the Prince of Wales’s vision of creating communities for a more sustainable world” (*The Prince’s Foundation | About*, 2022). Despite its outwardly charitable intentions, its vision of “creating communities” strikes as a continuation of British imperialist tendencies to make the world in its image. The British royalty supported and benefitted from a “symbiotic relationship between crown and empire” (Cannadine, 2002). Through their reign, the House of Windsor maintained this relationship, presiding over the UK through the wind down of formal colonialism and subsequent expansion of the Commonwealth. The notion that members of the House of Windsor continue to make claims to “creating communities” in the year 2022 indicate a certain lack of reflection and acknowledgement of the royal family’s role in “creating” the modern, neo-colonial world.

The Prince’s Foundation exerted its influence over the early formation of SEM4ID, advancing discourses of sustainable development from a British vantage point. Andrew reflected on their influence during an interview:

Andrew: ...I knew that would come with a price, and it literally comes with a price, but they provide a level of the teaching during the course, and they were keen to set up a number of the projects. And at the time, they were going to be supporting, with their own people, a number of the projects. Now that subsequently changed for various reasons, but, they are still sort of heavily involved in trying to push the projects through their network. So their involvement going forwards now is that they will continue to provide the

teaching, their marketing people will now start to market the course and we're going to try and use their network to try and get more sponsorship in support for our students into the projects themselves, as well as using the network obviously to try to link up with other potential projects and stakeholders and community elements in the future... (interview, March 27, 2018)

The Foundation also exerted power over the nature of student projects. For instance, the connection between the students and the Community Cooker Foundation was established by the Prince's Foundation.

Andrew: ...Sierra Leone is messier still, I mean that was supposed to be around diversifying, and again, it wasn't a question, they were given a solution and they were looking at diversifying the energy outputs, or the use of the energy outputs from a community cooker... we were going to be doing that in Kenya but that ran into problems because the elections, so we had to re-deploy them in Sierra Leone there was loads of politics around moving the technology, we were pretty much pushed by the Prince's Foundation and partners....(interview, March 27, 2018).

Students were informed about the commitments of the Prince's Foundation:

Luke: ... The Prince's Foundation, they are architects and do a lot with heritage building and agriculture, but have started doing some development projects, they have a lot of influence over the course, had thrown some money for CCF (Community Cooker Foundation) to do some work in Sierra Leone...(interview, June 8, 2018)

The relationship between SEM4ID and the Prince's Foundation entrenched a certain way of conceptualising the relationships between the University and community-based partners. This conceptualisation was deepened through Community Engagement, a module that the Prince's Foundation co-taught alongside lecturers in the engineering department. The module aims of Community Development were as follows:

Module Aims: In the last 50 years community groups have demanded and increasingly been offered an important role in planning and designing new developments and large scale engineering projects. Today, in an environment of localism and nimbyism, with local residents increasingly seen as 'experts' in their own right, community engagement has become a crucial part of any development process. The module will introduce the role and importance of engaging communities, teaching various techniques of consultation and engagement, placed in a framework from top-down to bottom-up. These

techniques will be placed against a range of critiques of engagement that have emerged in recent years, from the accusation that engagement silences, co-opts or manipulates local people. The module will include evolving examples of engagement such as the ‘charrette’, ‘Enquiry by Design’ and others, and will include a practical project in which students take part in engagement exercises.

In this descriptor, there is the implication of asymmetrical power relations between “community groups” and an invisible narrator. If community groups have been demanding and increasingly offered a role in planning and designing new engineering projects, *who* have they been demanding this from? We can infer the invisible narrator may be someone who has traditionally held power over the entire process of development. This person or group likely is from the West and has expertise in engineering. By situating this invisible narrator in the context of a module descriptor, students reading this text can easily step into the shoes of the invisible narrator, becoming the expert who holds the reins of power, controlling the nature and extent of engagement with “local people.” The Prince’s Foundation and engineering lecturers, who represent those who have been in power to decide on the course of development on behalf of “community groups” for centuries, are once again reinforcing these power relations, and training a new generation to take up their mantle.

But the Prince’s Foundation was not the only influence in the formation of the conceptualisation of “international development” in the SEM4ID programme. The course involved a number of modules taught within the School of Social Science, including Introduction to Development Studies, Tools for International Development and Monitoring and Impact Evaluation for International Development.

Introduction to Development Studies establishes the social and political context that the students would be working in. During one of the module sessions, I noticed that the conversation was rooted within Western discourses of development. The British and European staff and students on the course seemed very comfortable within this discourse and dominated the conversations. I reflected on this after sitting in on some of the module lectures.

Back in Anders’ Monday lecture. I noticed this the last time I was here, too, but the way that Anders and some of the white, European students talk about SSA

[sub-Saharan Africa] and other developing nations is very “othering.” Not only do they dominate the dialogue in the classroom (frequency of weighing in), they talk about these nations as “developing,” in terms of poverty, in terms of evaluative statistics (observation, October 22, 2018).

There were students from the “developing world” sitting in the room and I noticed that these students were quieter in the context of this conversation. It may have been because those students came from an engineering background and were not as familiar with the content. Yet some of the European students and staff were engineers, and they seemed to have no hesitation to weigh in. It may have also had to do with different school cultures. In the West, students are encouraged to participate in discussion from early ages, whereas in other parts of the world, there is more of a hierarchical structure, where students are taught to listen to the teacher. But I could not help but wonder at the time if the differences in their levels of participation had more to do with the nature of the conversation, being dominated by Western thinking and the marginalizing way the Western staff and students spoke about “the developing world.”

... there are people from around the world, including Africa and South Asia in this room. I wonder how the various students in the room feel about the nature of the conversation about Africa, poor/developing nations, poverty, etc (observation, October 22, 2018).

I never had the chance to ask the non-white, non-Western students about this particular dynamic. But I’m not sure they would have spoken with me openly and directly about this even if I had. Despite my marginalised Jewish background, I have assimilated in the West and am racialised as White. On the surface, this means I may come across as part of the same structures and relations of power as the rest of my white, Western counterparts who were in that classroom. I sensed this neo-colonial, racial difference when speaking with a student from the global South about his experience doing field work, versus that of his white peers, myself included.

GOW: Can you describe ... the differences that you saw between the way
Zambians interacted with you versus white people or other non-African
people?

Samuel: I don’t think this question... it would have been good if some of my
white colleague gave their story and I give my story.

GOW: Okay.

Samuel: Because...

GOW: Just from your prospective, like, did you notice any differences and if you did can you articulate them. If not that's ok, too.

Samuel: I'm trying to figure out.

GOW: Yeah.

Samuel: I mean my white colleague, how they interact with me here, because I didn't interact with any white person.

GOW: No, I mean when you were in the field in Zambia for instance and we were going around together or you're going out in the field with Hari.

Samuel: Sometimes myself alone yeah. It's not something that I've actually thought of, any differences that much.

GOW: Okay.

Samuel: Yeah.

GOW: That's if you think of anything you can say but don't worry and you will not offend me.

Samuel: Yeah, I don't think because, you know, we went as a group, and we knew what we were after even with the under grads we were there on a common purpose, so everything just worked perfectly. But I will say that, as I have already talked about some of the few challenges some the Zambians some of them feel like we are helping you and so you need to ...exercise a little bit patience, because I remember I went to in Monze one organisation the guy was so busy, he didn't have time, I spent about four hours ... I was like please I have only one day and if you could be of help, till I beg him ... I had already taken the letter to go through their higher authority they've signed brought referred to him so it's like the courtesy aspect bureaucracy had been fulfilled but he basically didn't have time...

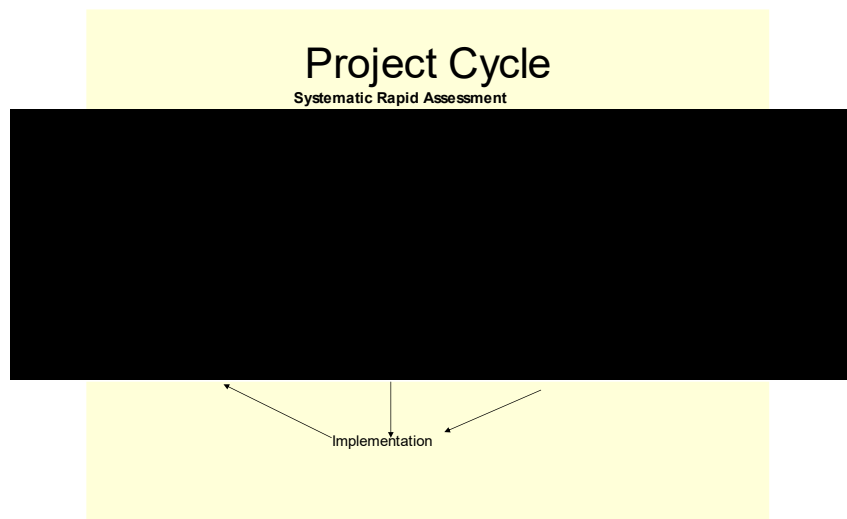
GOW: Right.

Samuel: Yeah, but like expected him to at least sacrifice some thirty minutes to go through that. Yeah, but like I didn't have anything to compare among my white colleagues. I don't think I have anything on that grounds.

In this dialogue, Samuel seemed to hedge or avoid answering my questions about racial difference directly, though I had a sense there was more to the story than he

was willing to share. He may have just not perceived those differences to be relevant or important, or it may have been that I did not ask the questions in an appropriate or effective way - that I could not say. But I could not help but feel he was holding back in his answers. I felt I had hit some barrier that was unlikely to be overcome quickly.

During another social science module in SEM4ID, students learn about social research methods to support their field work. Below is a slide from the module, depicting a project cycle for “systematic rapid assessment.”



Though the class where this project cycle was taught involved considerations of “participation,” the framing of participatory methods still seemed to rely on an outside “researcher” who assesses the lives and “issues” faced by a community/stakeholder group. The researcher takes the lead in collecting and analysing information and formulating an intervention. The assumption within this module was that participation can open “up the possibility of involvement in planning and management of development projects and programmes” (observation, December 2018). Western development teaching and interventions appear to hinge on the process of stakeholder engagement, as if, by “engaging with stakeholders” or “engaging with community,” Western outsiders can help to surface or determine “needs” and then deliver “solutions.” This framing reinforces the notion of the supremacy of the Western knowledge system.

I sensed that the way development was framed in this, and other modules, helped create the conditions where references to the “developing world” and the “Third World” were commonplace and acceptable. During a group meeting between

students and staff to discuss final dissertation projects, one student made generalisations about “really high numbers of people” in the “developing world” and their approaches to cooking. This related to his technical dissertation, which was focused on a community-based model of cook stove technology for Home Leone.

Luke: ...Start[ing] with the problem, ...really high numbers of people in the developing world still cooking off open fires and simple stoves and obviously this contributes to a lot of premature deaths and respiratory-based illnesses, mainly. ... we've known this a long time, and there's been lots of interventions that have looked at sustainable cooking solutions. Like ... clean cookstoves is massive, you have community cooker...and, you know, there's a number of reasons why these aren't as wide spread as it could be and I think, to give an example of one, it's gender dynamics, because you know, it's the women who cook, but it's the men who hold the money quite often and then they don't want to invest in a better stove for their-for-for their wife to cook or what have you... So it's interesting, there's lots of stuff already happening. But it's quite slow in this field because of those gender dynamics, because that market doesn't exist and then particularly, I think the power thing's really interesting because like what Biolight, that company with the stove is doing ...they're looking at where you can use the waste heat to generate electricity, well this is really interesting, because what it means is now there's an in-, of course, like, we'd like to see gender mainstreaming, and we'd like to progress towards this, but now you've given a reason why the man now wants to upgrade his wife's stove, because now he can charge his phone on it. So, he has an incentive to go and buy a better, more efficient stove...

I was struck by the way that Luke, a British student, discussed the “developing world” and issues of gender relations within it. He spoke in generalities about how men and women divide labour and spending, across the developing world, failing to differentiate between national, tribal and/or ethnic identities in cooking preferences or habits, or gender relations. He seemed confident in the Western development approach that Western-developed cookstove technologies could help bring “progress.” His assuredness and righteousness gave the impression of his authority over the path of development of others: “we've known this a long time” and “of course, we'd like to see gender mainstreaming.” The “we” in his statements seems to refer to him and people like him – white, Western holders of superior knowledge of how development should occur.

The normalisation of us/them, developed/developing seemed to help build a saviour/saved paradigm between SEM4ID staff and students and their community partners. I noticed this in the way that staff and students talked about “empowering people.” By “empowering” their community partners, SEM4ID staff and students could connect themselves to a higher moral purpose in driving the development of and helping their partners.

For instance, during a meeting with the Zambia team in country, one student talked about her views on the relationships between the local students, the school itself and her project.

GOW: ...[tell us] how it's been so far, you've just touched down, first impressions again for your second time back.

Alyssa: ... I feel like it's been a lot more of a productive trip than I was imagining it to be. I feel like it's a very different atmosphere to the one that we had in March. It's a lot more welcoming, I wonder whether the fact that the Head Teacher has only been in her position a couple of weeks last time, and now she's given more of her own stamp on how the school is being run, how the school plans to develop. And she's really behind these ideas that we also have of sustainable development and cooperation in development. She wants to work along the same lines as us, so I found it more productive than I was imagining it to be and I think I'll get more out of this trip in Siavonga than initially I thought I was going to...[my] plans for the rest of the week – trying to think about it quite a lot, I still want to have those conversations with the students and with the teachers. I think talking to the students, particularly today, they find it a very empowering thing, to be able to give their opinion on their school and what's really obvious is that they're really, really proud of their school and what they have, they love going to school and to capitalise on that and make them feel that they do own their school and it is theirs and development opportunities in the future need to involve them to continue to empower them so the future of development and the future of these projects can lay with them, and it's no longer this top-down approach and we can do this stuff in co-operation (observation, August 15, 2018).

This student talked about how she perceived the Head Teacher of the local school was shared SU's ideas about sustainable development and seemed amenable to “cooperation in development.” She mentioned how the students were “empowered” by their ability to give testimony about their school to her and her peers. She asserts that development needs to include the students, empowering them

in their ownership of the development. In talking about other people's empowerment from her own perspective, this student fails to acknowledge the voice of those people. Instead, she speaks for them. In making assumptions about what they need, about what will "empower them," she takes away their agency to decide for themselves. She extends this thinking in a reflective account:

"A twelve-year-old boy questioned his own benefit to us asking imposing questions about his education and this provides significant food for thought. From the eyes of the children it is evident that they do not feel particularly empowered against (particularly westerners) coming into their school and 'doing' development. In the future, it is surely essential to try to empower these people, particularly the children who act as the future of their development, in order to produce projects which are truly collaborative and also meet the needs of the people we are trying to *help* [her emphasis]" (student reflective account, September 21, 2018).

This student seems to miss the fact that development frameworks and funding are predominantly led by the West. Modern conceptualisations of what development should be are largely set and driven by Western aid bureaucracies and budgets. In the United Kingdom, Parliament sets the strategic aims and budgetary support for foreign aid through an Aid Strategy. This strategy and corresponding budget are then administrated through departments, such as the Department for Business, Energy, and Industrial Strategy and the Foreign, Commonwealth & Development Office. Non-governmental bodies, such as UK Research and Innovation, set further direction and conditionalities on resources for foreign aid through funds like the Global Challenges Research Fund (GCRF). GCRF "supports cutting-edge research to address challenges faced by developing countries" (*Global Challenges Research Fund*, 2022, para. 1). Taken together, a picture emerges of a robust infrastructure for the aims, direction, and priorities of development, that are set and controlled by British political and social interests. These interests may or may not align with the recipients of that aid; regardless, recipients have little control over the overall fate of their own development. Though some of these structural conditions were mentioned during taught modules (particularly in Introduction to International Development), the lessons did not always appear to translate into students' praxis or world views, as expressed in their coursework or discussions with me.

Another student on this team seemed to have similar understandings and expectations of who holds power to *empower*. In a critically reflective account, this student reflected on the relationships between the University, herself and other SEM4ID students, and their community partners. In her reflection, she acknowledges that “principles of international development that we had been learning in our final modules such as accountability and participation had not been a part of our project.”

“It was an oversight that no terms of reference were prepared for our project from the start because this would provide clarity within the scope which could have helped better manage expectations. I feel a grievance procedure should also be explained to the client so as to empower them and a memorandum of understanding should be in place to clarify the relationship between the two parties. In hindsight, I think that the project was well intentioned but lacked a fair management structure” (student reflective account, September 21, 2018).

This student implies that had the University or the students provided their community partner a “terms of reference” and a “grievance procedure,” that the partner (or “client” as she also refers to them by) would be “empowered” within the scope of the project. This is consistent with what she had been taught in modules: through good management of the partnership, it is possible for community groups to participate, and through that participation comes empowerment. What this conceptualisation fails to acknowledge is that this way of working sets up asymmetrical power relations as the default. Students walk into the partnership with the assumption that they (or, as this student argues, the University should) have ultimate managerial authority to set the terms and conditions of the “partnership.”

This student also recounted an instance where her supervisor reinforced this unequal power dynamic. This supervisor, during meetings with staff at the Siavonga Primary School, talked about how the university’s role is to support the school so “that eventually it will be empowered to drive its own development; ‘There are no handouts’” (reflective account, September 21, 2018). I was in attendance at this meeting with the SEM4ID students, their supervisor, the Head and Deputy Head of School. My impression was that the Head of School and the Deputy embodied two versions of how asymmetrical power relations play out amongst “community members” who are recipients of Western development programming. On one hand, the Deputy Head seemed very receptive to Western aid, and in fact, demanded it. On

the other hand, the Head of School pushed back on a paternalistic form of aid. Instead, as the student above reflected, “she [the Head of School] mentioned that she did not want to be handed things on a silver platter only for the door to be shut at a later date and them to be left in the lurch. She stated that any interventions now and in the future should involve discussion and participation from the school” (student reflective account, September 21, 2018).

Although the Head of School talked about discussion and participation, I sensed that she wanted more than that – she wanted autonomy and the freedom to decide what would happen for her school. However, she also knew that she needed additional resources to enact the changes she wanted for the school. In using the language of Western development discourse, she was speaking the language of the people in power to get what she needed, and in effect, subverting the power differential. Her reaction – the mental labour and diplomacy – that she needed to enact in this scenario was only further evidence of the asymmetrical power relations between the SEM4ID staff and students and the school stakeholders.

Upon reflection, I could not help but wonder if “empowering people” is a new, coded form of the colonial binary opposition of civilized/barbarian, a trope that helped construct the notion that Western knowledge and technology far exceeds that of African. The use of the phrase amongst students and staff in relation to Zambian “partners” demonstrates a certain air of supremacy of a Western knowledge system, which has the power to “empower.” Though I believe these students and staff were likely naïve to their participation in these “regimes of representation,” without active confrontation and critical reflection on discourses of development and the power relations they reinforce, SEM4ID students and staff were unwitting participants in them.

Africa and African stereotyping

It was a regular occurrence throughout my time working with staff and students on the SEM4ID course to hear reference to their field work in “Africa.” During a presentation of their technical projects midway through the year, students on the Zambia team repeatedly referred to their project in “Africa,” rather than specifying that their work would be localized in particular parts of Zambia (observation,

February 9, 2018). During a meeting with the HoC, on student referred to their work in “Africa,” not their specific work in Sierra Leone (observation, March 23, 2018). This was striking, considering the goals of the course were to push students to drill down into their specific contexts. It begged the question as to whether students had embraced or fully understood the importance of being specific. The fact that they were speaking in generalities indicated they did not.

Specificity, especially when we are talking about doing work in particular places, helps ground the work, humanise it, acknowledging local and regional differences, quirks, and assets. Speaking in generalities is not just disrespectful, it carries an air of coloniality. Van Stam argued that “when approaching Africa ...as if it is *a country*, we strengthen the *racial views* grounded by Comte de Bobineau and introduced by colonial powers” (van Stam, 2013, p. 2).

The racial views that Van Stam alludes to were part of a wider trend to separate “them” from “us,” setting up a power relation between colonized and colonizer. This dialectical view of self vs. others was expanded by Edward Said in his seminal work *Orientalism*. Said is credited for demonstrating how:

“the [Western] ‘study’ of the Orient, ‘was ultimately a political vision of reality whose structure promoted a binary opposition between the familiar (Europe, the West, “us”) and the strange (the Orient, the East, “them”)’. He shows that this opposition is crucial to European self-conception: if colonised people are irrational, Europeans are rational; if the former are barbaric, sensual, and lazy, Europe is civilisation itself, with its sexual appetites under control and its dominant ethic that of hard work; if the Orient as static, Europe can be seen as developing and marching ahead” (Loomba, 2002, p. 47).

This work became a critical foundation for a wide range of studies highlighting the “dialectic between self and other” (Loomba, 2002, p. 47) which underpins colonial relations between Europeans and non-Europeans, including Africans, Native Americans, and others.

There were a number of speech acts by members of SEM4ID that implied a sense of “us” vs. “them.” Andrew, in describing the skills he was hoping to instil amongst engineering students through experiential learning projects, evoked a dark sensuality of African lands:

Andrew: In that international development context, but also generically, because I know that that makes great engineers, irrespective of whether they go work in deepest, darkest Africa, or whether they go and work down the road in TATA Steel, it makes no odds, the skillsets are actually still fundamentally the same (interview, March 27, 2018).

I found his description of the physical setting to follow in the “tradition which colonizes the non-Western landscape for the purposes of an emerging modernistic aesthetic: Africa serves as the spatial projection of the dark void at the heart of modern life” (Spurr, 1993, p. 95). Referring to somewhere in Africa as “deep” and “dark,” Andrew evokes a sense of wild sensuality - nature untamed. An uncivilized place, where British-trained engineers, if they are trained in the way that he prescribes, can go and create order, bring technology, and do great work. By asserting that the skillsets involved in “making great engineers” are the same, regardless of where they are working, Andrew either does not know or understand, or actively ignores the vast power differentials that make working in “deepest, darkest Africa” so very different from working at TATA steel (an Indian-owned, modern steel factory, based in a nearby town in Wales).

In a group meeting between SEM4ID staff and students, Andrew comments again on the physical experience of being in an African country, joking about the Zambian heat.

Becky: Yeah, and even in Siavonga, whether classrooms are more, like, traditional, per se, is... ‘Cause there’s no literature to say that people are too hot, you know, maybe it’s an assumption that they are and they’re uncomfortable and it could be better, but... Yeah, if you could learn lessons from both of the ways things are done, then maybe that will drive better development.

Victoria: Yeah.

Andrew: ‘Cause you have clear guidance here on what is too hot for a classroom for children before you have to effectively evacuate, don’t you? (**Becky:** Yeah). I very much doubt they have this there, [some laughter] it’s probably like 500 degrees and everyone’s effectively cooked, but...(observation, June 10, 2018)

In an interview with one student about their project in Sierra Leone, they referred to their introduction to engineering field work in sub-Saharan Africa, during a period of work in Liberia, as time spent in “the bush.”

Luke: And then I got to know Andrew during this sort of, 8 days that we spent in Liberia and we went up to the bush, and you know, we-we built trailers and we worked together and it was very much a team effort and you know, we took a couple of fixers that Jim knew, a couple local guys that Jim knew, one mechanic and one sort of, fixer, who just-just knew all the right political people. And then we went there and um, we built a series of, like, 4 or 5 trailers, and-and then that was when I was like this is sweet like, this is really-really, this is really cool, um, this is what, like, I want to be doing. Like, I'd always got a passion for travel, (G: hmm) and a passion for-for that kind of stuff (interview, June 9, 2018).

This student seemed invigorated and inspired by this kind of experience – he had a “passion for travel” and for “that kind of stuff.” On the surface, this comment may seem innocuous. Yet describing areas of Liberia as “the bush” evokes that same sense of untamed, uncivilized nature, as when Andrew described the “deepest, darkest Africa.” These comments reinforce the “us” vs. “them” binary opposition between the former colonizer and the former colonized.

Conclusions

The preceding chapter aims to extend the exploration of the social scenario beyond surface level actions and patterns of behaviour, to uncover signified meanings and systems of meaning, i.e., discourses, that were conveyed through language acts. The aim was not to call attention to individuals. It was more so to demonstrate that our modes of thinking and relating to one another continue to be shaped by discourses of development and coloniality. The fact that colonial discourses would appear in this study came as no surprise – we still live in a neo-colonial world. As Escobar (2011) reminds us, “...discourse produces permissible modes of being and thinking while disqualifying and even making others impossible” (p. 5).

Chapter 7 - Resistances

Introduction

Thus far, this thesis has outlined the ways in which SEM4ID reproduced colonial relations of power through practices, discourses, and institutions. But this is not the whole story. Alongside reproduction were also many acts and efforts to resist various power dynamics that arose throughout the year. This chapter explores those efforts. I will provide an in depth look at critical reflection, one pedagogical strategy applied in SEM4ID that helped to elucidate critical perspectives amongst students, and by extension, staff, as well.

As part of concept development modules, which provide a foundation for students' engineering design work, students are asked to submit two critically reflective essays, one at the midway point and one final submission at the end of the year. Reynolds, a critical management scholar, provides the theoretical framework used in the instruction of critical reflection in this program (Reynolds, 1998). Informed by the Freirean ideal of using reflection to inform action, Reynolds defines critical reflection as a process that should: question taken-for-granted assumptions; be social rather than individual; be concerned with revealing power relations, and; be directed towards emancipation (Reynolds, 1999). SEM4ID students were directed to additional resources to inform their reflective practice, including Revans, Humphreys, and Gibbs (R. Revans, 2011; Humphreys, 2005; G. Gibbs, 2001).

Students are free to choose the topics of their writing, though suggestions have been provided to help catalyse their reflections. Suggestions have included focusing on a "critical incident" (one that gave them pause or provoked an emotional reaction) (Gray, 2007), or on their performance during a leadership exercise during one of their classes. Once students decide on a topic, they are invited to use it as a point of departure to:

- Critically analyse their own and their teams' decisions
- Consider other perspectives
- Analyse how they have dealt with structures and relations of power throughout their projects.

Students are required to use the literature, including, but not limited to, peer reviewed journal articles, blogs, religious texts, newspaper articles and social media, to help them more rigorously challenge their assumptions, explore critical questions, and extend their understandings of themselves and the world around them. They are discouraged from using the literature to merely validate their claims.

Beyond the structure of the assignment, students are provided with robust guidance and mentorship by faculty involved in the program. Each project team had a primary academic mentor, but students were encouraged to and often did go beyond their primary mentor to gain feedback and advice about their critical reflection work both before and after assignments were due.

This chapter explores the outcomes of student reflections, collected from two cohorts enrolled during the 2017-2018 and 2018-2019 school years. It is an adaptation of a paper published in 2020 in the American Society of Engineering Education conference proceedings (Orbaek White et al., 2020). The following work was led by me, with support from and analytical contributions by the co-authors.

Methodology

It was through my own praxis that I recognized the critical reflection work that student were doing was practically and theoretically interesting. Since I started my doctoral work and embedded with the first SEM4ID cohort, students have approached me at various moments to discuss the challenge and the value of their critically reflective writing. I observed several students undergo personal and professional transformation throughout their time in the course. Though I would not draw a causal linkage, based on experience, alongside knowledge of literature in this area, I (along with my colleagues on the research team) postulated that having students critically reflect on their experience, positionality and decision making throughout the year, may have contributed to these transformations. After two years of intensive engagement with the development of the SEM4ID program and with students enrolled on the program, I was curious to know what was emerging from student reflective accounts. I recognized that a deeper reading of students' critically reflective accounts could teach us a great deal.

However, since the decision to incorporate critical reflection into the SEM4ID curriculum was pragmatic and grounded in the collective experience of the developers of the program, and because there remains a paucity of studies that delve into the context and content of critical reflection in engineering education, I was unsure what students would produce through their critically reflective work. Therefore, my research team and I decided to take a wide and exploratory stance to this research. Our overarching research question that guided our analysis was: *what happens when students (in this context) are asked to critically reflect?* We used two years of student critical reflection submissions from the 17/18 and 18/19 school years – a total of 21 essays.

Analysis of student reflections was informed by Braun and Clarke’s inductive thematic analysis. Rather than drawing from theory, inductive thematic analysis involves the development of codes from the ground up and allowing broad themes to emerge from the data and initial sense making. It involves the researcher developing a deep familiarity with the data at hand and comparing earlier and later interpretations of the data to ensure codes and themes “fit.” My research team and I recognized the influence of our theoretical sensitivities we each brought when reading student’s reflective accounts. We therefore acknowledged the role of critical reflexivity in informing the development of codes and themes, and how we made sense of the data.

We also challenge modernist validity arguments, where the subject of research (ourselves and the students) is somehow linear and knowable. Instead, through iterative, critically reflexive interpretation, we attempt to move toward a postmodernist interpretation of ourselves and our students (and their work), whereby we acknowledge the contextual, situational, and changing nature of our own interpretations of our subjects (including ourselves) (Pillow, 2003). Therefore, we do not attempt to make any fixed truth claims about the students’ work or our own interpretations of their work. Instead, our aim is to provide an interpretive offering to fellow educators about the application of critical reflection in engineering classrooms, in response to growing trends in the use of reflection in engineering education.

This process can benefit from having a research team, as it brings together multiple perspectives to the analysis, and helps ensure a deep and thorough review. As such, each researcher that contributed to the following analysis completed a “close reading” of students’ essays independently. We did initial coding individually, then came together in person to organize our thoughts and reflections into broader themes (Braun & Clarke, 2006).

Results

In the following results, we provide direct quotes from student journals, which emerged to us as exemplars of the overarching themes presented below. It is important to note that these are not definitive themes – the authors discussed and debated the characterization of these exemplars at length. The characterization the authors provided below is the result completed as of 2020, though this work is still ongoing and may evolve.

We provide notes on students’ identity, as they have served as points of departure for some of our reflections and reactions to students’ submissions. As appropriate, we use the commonly used British acronym BAME, or Black, Asian Minority Ethnic people. Though the use of “BAME” is contentious within racial and ethnic minority communities, we use it in this paper as it remains the convention in the UK, and we believe it is sufficiently general that it reduces the risk of providing specific identifiers that may breach confidentiality.

Evidence of transformation

Upon close reading of student submissions, we came to find compelling, thoughtful, and insightful reflections across a range of topics. Many students reflected on scenarios through the lens of history of development and colonisation. Some questioned their role as early career development practitioners. They challenged previously held notions that they were “there to help” and instead, began to recognize synergies that can come from co-production, relationship building and respect. They also challenged the role of institutions, like Swansea University, in participating in what they considered may be an extension of colonial development regimes.

Learning about and questioning Western-led, (neo)colonial development

"The connotations of Sierra Leone's colonial past are ever-present both officially and unofficially (DFID/ UKAID) and this permeates to create an inextricable link that transcends multiple issues such as race, identity, power dynamics and team dynamics. Of course, it is difficult to accept initially that the legacy of our colonial past to a large extent has framed the complex operating conditions in which we are working. I have long been aware of the implications of colonialism due to my background in Modern History and International Relations and interest in development economics. Yet, until I witnessed that first hand, I had never really appreciated its significance and how it is translated in day-to-day interactions." – Student 11, (male, white, non-engineer)

Questioning their role in development practice

"And how exactly were we able to build something to help these people? We were all students with no practical experience... We did not want Sierra Leone to be our "playground", a liberated space in which the usual rules do not apply (Cole 2019)" Student 1 (female, white, engineer)

"I have found myself questioning many things, but mainly if development in this context is aimed at helping the 'receivers' or the 'givers' to develop. This is something which has been questioned before, whereby trips of this nature have become 'about us, rather than for others' (11). Mary Lundy states that service learning is aimed as a mutual benefit to students and the community (12), however in this context I believe the benefits for the students are achieved through the lives of others that may not see any gains" Student 7 (female, white, non-engineer)

"The trip created many negative feelings for me, and made me question whether our intervention was worthwhile. Will we really affect people's lives? In addition, if not, is it really ok to implement these projects in developing countries - simply as a learning experience for students? Isn't that exploitative?" Student 12 (male, BAME, engineer)

Updated, more critical sense of professional identity and direction

"If life will offer me another opportunity to work in a developing country, I will go there with an open heart, without trying to "save the world", with many lessons learned about their country and culture and just as many to be learned. I would be ready to collaborate with the community without being scared of uncertainties, but rather be curious and excited about them. If we were "lucky" enough to implement a tangible project for the beneficiaries the first time, the

next project will include even more community engagement and collaboration with the residents involved. They know better than us anyway." Student 1 (female, white, engineer)

"These experiences also surfaced for me a sense of hypocrisy for concentrating my efforts of development work abroad as opposed to my nuclear community. In doing so I begin to unearth deep-rooted feelings of confusion and anger in the search for my own identity and purpose in development." Student 21 (male, BAME, engineer)

Notably, some of the engineering students articulated new perspectives they had developed through their projects on the importance of the social and political context of their work. In some cases, they acknowledged that the social and political context may be more important than the engineering intervention itself.

"As a novice practitioner in the field of development, and coming from an engineering background where working with rigour and structure to systematically work through problem solving resolutions has been my experience, I have come to realise and appreciate the importance and value of the context in which development takes place and how social science and other concepts play an equally important role in development projects around the world." Student 4 (female, white, engineer)

"When I travelled to Sierra Leone and visited the slum, I felt that development is an almost entirely social and political issue – engineering was just a way to facilitate the social and political change required for progress." Student 12 (male, BAME, engineer)

Through the narration of their experiences and reflections in their essay submissions, my research team and I found evidence of students moving through various stages of a journey toward a more critical mindset. We characterized these transformations in thinking as *development of critical consciousness*. We arrived at this conclusion through the exploration of various theoretical perspectives, including Action Learning, acknowledging the social nature of learning, and the imperative to apply questioning insight to programmed knowledge in order to arrive at true learning. We also recognized the influence of Freire's concept of 'conscientização,' or conscientization, the process of developing critical consciousness, and the emancipatory pedagogy of hooks, which seeks a democratic and engaged way of learning, within the Action Learning literature. The team came to consensus that the learner (both teacher and student in the traditional classroom) develops critical

consciousness through an insistent probing of assumptions and working to understand the impact their own lens has on their interpretation of situations. In the classroom, this means learners are engaging with questions around structures of power and a social perspective aiming for emancipation.

Bumps along the way

Development of critical consciousness is not a linear or finite process. Opening the door for students to critically reflect on their experiences did not mean they were able to find resolutions. As mentors, we encouraged students to allow some of their issues to remain unresolved – that they were dealing with “wicked problems” (R. W. Revans, 1971) that may not have clear beginnings, middles or ends. One issue that emerged from students’ journals was a tension between engineering and social science. On one hand, there was a recognition of the importance of social and political context across students’ disciplinary backgrounds. However, this did not necessarily mean it was simple or straightforward for students to integrate these perspectives into their work.

“There was certainly a belief that I was on the team to ‘do the social stuff’ required on the course, from both myself and my fellow team members. There was an underestimation of the significance of the social science, in the fact that social science principles must be applied to any development project, in a sense they must precede engineering ... Whilst there were attempts to implement social sustainability from the outset, in terms of a community engagement strategy and stakeholder communications plan, these documents were largely ignored when we were actually doing the project.” Student 15 (female, white, non-engineer)

“It was before the first trip to Sierra Leone when one of the social scientists in my team had a strong belief that the engineering project must be the social scientists’ choice rather than a common decision, and the same with any social aspects of the project. They insisted that the engineers should look for technical solutions while the social scientists talk to the community, conduct interviews and communicate with other stakeholders. This division of tasks blocked team communication numerous times, mainly because most of the skills taught this year were social skills and modules focused more on the social aspects of an intervention and I was advocating for a common action. My reaction contradicts Leydens, Lucena and Schneider (2012) who suggest that engineers have the tendency to focus on isolated divisions of labour rather than collective decision-making or collaborations. Borrego, (2006) also

suggests that engineer's type of collaboration is a reflection of the division of labour characteristic to engineering activities. But my position was different. Why was I learning these things if I was not using them? And why I believed that I was entitled to take part in those actions while others didn't?" Student 2 (male, white, engineer)

In spite of it all...

Though we found many examples throughout student reflective work that indicated the development of critical consciousness, we found perhaps an equal number of examples that we interpreted as naiveté, for instance, in a lack of acknowledgement of the complexities of building authentic partnerships with community stakeholders or of navigating structural issues of race, post-coloniality or gender:

"I found it very easy to talk to the workers in Home Leone. It didn't take long for MB, the main welder to become my friend. Our relationship was mostly pushed by the circumstances, but it was based on mutual respect and most important on having similar personalities." Student 1 (female, white, engineer)

"This isn't to say that I was dealing with dramatic race issues while I was down in Zambia. This couldn't be farther from the truth. The Siavonga community respected my knowledge, work ethic and knack to speak in the local language. An entire community's perspective can change quite quickly when each morning you say good morning to fifty different people in their language on your walk to work." Student 5 (male, white, non-engineer)

".. I find gender roles to be an interesting topic. In many ways, our team has obliterated gender stereotypes in an engineering project with two female engineers and one dominant and one quiet of each gender. But in terms of the job roles that we have assumed in the team, Will [a pseudonym] being the presumed leader and me the organiser, I find it interesting to observe where we have naturally slotted in." Student 6 (female, white, engineer)

Acceptance (however subconscious or unintentional) of dominant ideologies that maintain status quo

"What's the point of any of this, if the beneficiary continues to take and never learn? The whole point of this agreement was for their own betterment and empowerment. The beneficiary is clearly taking advantage of the donor." Student 5 (male, white, non-engineer)

"I asked if he would teach me because I wanted to learn and to contribute. He looked at me with a certain amount of amusement, but said yes. I spent the whole day watching him work and trying to input where I could but, contrary to his agreement to teach me, he effectively ignored my presence" - she later reviews this 'But actually as I contemplated this, I thought that I wasn't really offended by N, more frustrated with myself for not already knowing how to be practical" Student 6 (female, white, engineer)

Discussion and lessons learned

What happens when students critically reflect?

Upon reflecting on the results we present above, we were able to reach some tentative answers to our research question: *what happens when students (in this context) are asked to critically reflect*. Principally, we realized that some students in the SEM4ID program showed signs of an evolution toward critical consciousness, or a gradual recognition of their role in broader systems of oppression and structures of power, and the change in actions and decisions they reported due to their new awareness. We use the terminology *critical consciousness*, as it is consistent within Freire's theoretical framework on critical pedagogy. While we have used this characterization of students' experience here, we recognize there may be other metaphors or conceptual frameworks, such as spiralling (Mao et al., 2016), sense making (Balogun & Johnson, 2004) or threshold concepts (Meyer & Land, 2003; Kabo et al., 2009; Baillie et al., 2013), to explain the learning processes the students report.

We emphasize that we noticed this evolution in *some* students, not all. While some students appear to use their critical reflection assignments as a way to avoid reproducing unjust relations of power, others seemed to resist change or recognition of their role in reproducing structural injustices.

Taking this further, we were curious to see if there was a relationship between students' academic background and the degree of "criticality" of their reflections, or the extent to which they were able to apply critical theories and analyse their own experience through them. We had initially assumed that engineers may struggle to in their ability to get critical, due to a culture of disengagement in engineering education, reported within the US (Cech, 2014). Ultimately, we did not

find a distinction between the degree of sophistication in critically reflective analysis between students with engineering versus a non-engineering background. We considered that the engineers who self-select into the SEM4ID program may be outliers, in that their level of social and political engagement may be higher than the average engineering graduate. We also appreciate that there may be varying levels of ability across students from all backgrounds to engage in critical concepts and conduct in-depth critical analysis.

These insights assume that critical reflection journals were sites where students would provide honest, transparent, and effortful accounts of their thoughts, feelings, and experiences. However, during our analysis, we acknowledged that student submissions may have been shaped by the power relations between student and teacher. Therefore, it is possible (and likely) that that we might not have gotten the “whole story” – that students were writing what they thought we wanted to hear, that some writing may have been more “academic” in style or tone than if students were left to reflect on their own without the requirement to submit it as an assignment, or that students simply weren’t invested or couldn’t invest in being critically reflective for other reasons. We considered how racial and/or cultural dynamics may have played a role in shaping students’ submissions, for instance. In the case of the 17/18 and 18/19 school years, faculty who assigned and graded the critical reflection submissions were white and British. We therefore recognized it was possible that students of colour may have held back in their reflections around race or coloniality.

There are likely many other factors that influenced the level of honesty and transparency in student submissions that we have not accounted for. We proceeded with demarcating some interpretive closures in part because in almost all the student accounts, there seemed to be some degree of either controversial, emotional, and/or raw accounting, which initially signalled to us that students were bringing their “full selves” to this work, and that we may interpret it as such.

Interviews or carefully constructed focus groups with students, perhaps facilitated by faculty outside of the program or non-faculty, may have helped clarify to what degree students were providing open and honest accounts of their inner workings. With that said, we are predisposed to question the extent to which the researcher could ever fully know their subjects or represent them through the

research process. We therefore want to emphasize to the reader that we do not intend for our interpretations of student reflections as direct representations of their original meaning or intent. We recognize that we will never fully understand the experiences of the students who wrote these reflective journals. Instead, we use our critically reflexive interpretation to inform practice. Given the significant rise in the use of reflective practice in engineering education, we hope this contribution will help illustrate the possible benefits *and* limitations of implementing critical reflection in engineering classrooms, as well as provide some guidance on how teachers can go about interpreting their students' reflective accounts.

Our relationship to the research as educators

In critically assessing our own role as educators and researchers, we began to recognize some of our own cultural and epistemic biases, particularly in relation to students' critical reflection assignments. For instance, I acknowledge that my feminism, fuelled by my bisexuality and regular critical questioning of patriarchal and heterosexual norms, heighten my sensitivity to gendered language while reading students reflective diaries. I may have been more suspicious of the level of critical consciousness development among students who I found using gendered tropes. Victoria, a product of European colonialism, whose parents and grandparents were raised variously in Myanmar, India and South Africa (from originally German, British and Portuguese heritage), has developed increased sensitivities to neo-colonialism within engineering education and practice. An early participant and former trustee of Engineers Without Borders UK, Victoria viewed engineering as a practical way of redressing global inequalities. Having been involved with several short-term pro-bono engineering international development initiatives, Victoria became uncomfortable with the paternalistic and product-driven aims of the schemes in which she was involved. She therefore may have been more suspicious of white, Western students' reflections that discounted or ignored the role of coloniality in shaping their experiences.

We provide accounts of our relationship to this research for many reasons, but primarily to make clear that our aims are not neutral: we aim for a more just world, and believe we have a responsibility as educators to contribute toward this goal. Studying the liberatory practices of Freire and hooks, for instance, we have

worked to emulate their styles of democratic and critical pedagogy, including assigning, as a way to build students' habits, toward scholarly practice of critical reflection and building their critical consciousness.

However, we also must recognize that students came to this program, and to their reflective work, with their own lenses and biases from all over the world. Their "lenses" are informed by the cultures and power dynamics that exist within their own communities. From our Western perspective, suggesting that students use critical theory and structuralism to question and analyse these power dynamics has felt natural to us. However, we recognize that these theoretical perspectives were born and developed in the West, and that theories and epistemic perspectives born in other parts of the world may feel more natural to students from other parts of the world.

Therefore, a lesson we take away is that when critical reflection is taught and assigned, it must be made clear that students should be encouraged and facilitated to draw from whatever frameworks make most sense to them. In effect, teachers must also be open and willing to learn from their students and adopt principles of critical pedagogy in teaching and learning, recognizing that development of critical consciousness is a continual process for all involved.

Critical reflection as assessment

At this point, we want to highlight that teaching, assessing and grading critical reflection assignments can be a radical epistemological and methodological departure for engineering faculty, who may be unfamiliar with critical theoretical perspectives (Ahern et al., 2012). In the early days of encouraging reflective practice in her students, Victoria admits she was expecting and modelling what she now recognizes as an instrumental form of reflection, distant from the questioning insight approach which necessitates exploration around moral or ethical judgement, and without a focus on surfacing implicit power relations. At the time, she did not have a solid framework or language for this critical aspect of critical reflection. Having been educated in the depoliticized, value-neutral engineering education paradigm, where questions of ethics and justice were seldom actively engaged, she found herself forced on a rapid and destabilizing journey towards more critically consciousness practice through engagement in this course. In practice, this occurred through being

challenged by me (through my role as “critical friend”) about her privilege, talking with the students about their field experiences, and reading the student reflections (which gifted her powerful insights into the lived experiences and struggles of students with personal histories and identities very different to her own).

Two years on from establishing critical reflection as a core method of assessment within the SEM4ID course, all of the authors acknowledge that each new batch of critical reflections is challenging and time consuming to engage with. Reading and assessing the critical reflections of the students requires us to be fully present, engaged with our values, maintaining awareness of our interpretative lenses, and looking always for the underlying story and indications of power dynamics emerging beneath the words that are written, and whether the students are identifying these.

Furthermore, what we read from our students often re-orientates our own outlook. Traditional engineering design, both academically and in industry tends be dualistic and requires objective and progressive trimming down of available information to the key factors that are pertinent (and ideally quantifiable!). The process of critical reflection is the opposite: it is personal in focus and opens up so many more avenues of thought and perspective – the questioning of underlying assumptions constantly moves the goalposts, the dimensions and nature of the field of play. We have found that this explosion of interpretation can be paralyzing at times, both for students and teachers. We have leaned on frameworks, such as Pillow’s “reflexivities of discomfort” to help us navigate these challenging waters (Pillow, 2003).

For all its good intentions, the SEM4ID MSc course itself started by reproducing an underlying attitude of Western superiority with implicit connotations of African passivity and dependence, and, in part, it was the students’ reflections that helped us to see this more clearly. We did not initially ask our students to research the history of the regions, nor did we ask them to reflect on the consequences of the UK slave trade that is still very raw to some of the community members the students were working with. However, these are some of the reflections that have emerged. Though it has not always been easy to look at ourselves in the mirror and recognize our contribution to systems of oppression, we have made a conscious decision to do

so, and have worked continuously to make changes within the degree program to avoid repeating our mistakes. We also acknowledge the important role that critical reflection will continue to play in holding ourselves accountable toward the goal of social justice.

Conclusions

This critically reflexive, thematic analysis indicates that assessing students through critical reflection may be a particularly valuable pedagogical strategy in contributing to the development of future engineering professionals who are better prepared to mount meaningful challenge to unjust power dynamics in their practice.

However, we acknowledge that critical reflection assignments are likely not enough on their own. Real-world, project-based work, under challenging conditions, appears to have catalyzed many of the “critical incidents” upon which students based their critical reflections.

The lessons learned from this research and our teaching praxis provide support for Nieusma’s assertion that a combination of pedagogical strategies – integrating liberal education courses into engineering curricula; embedding social justice content into technical courses; increasing critical learning thresholds around social justice through strategies such as discussion-centered teaching, small class sizes and engaging real world problems; experiential learning; and liberative pedagogies – can promote social justice in engineering curricula.

We made strides in this direction with the SEM4ID program, through a combination of liberal education coursework, small class sizes, experiential, project-based learning and critical reflection assignments. Our experience leads us to believe that embedding critical reflection into engineering curricula is necessary to push students to do the work of deconstructing dominant ideologies on their own, in their own way. Additional research would be valuable to understand whether students’ critical “reflexes” remain with them after they graduate, as they progress as practitioners.

In addition to our analysis on critical pedagogical strategies, we hope this honest accounting of our methodology helps to extend the work of qualitative

research in engineering education research and give future engineering education researchers an opportunity to explore and expand on postmodernist approaches to reflexive qualitative research.

Chapter 8 - Conclusions

This thesis aimed to demonstrate how the episteme of modern engineering, formed through forces of Western imperialistic and racialised colonialism, continues to act upon our practices and discourses within modern day engineering education. The episteme of engineering shapes and constrains our ways of knowing, thinking, being, and acting. In the introductory chapter, along with sections of Chapters 1-3, I laid out the ideological and institutional forces that perpetuate this episteme. Sections of Chapter 4 and Chapters 5-6 go on to provide empirical cases to illustrate this episteme in action. Taken together, this work aims to deepen our awareness and understanding of the structural forces that shape engineering higher education and how they play out in our modern context.

But this is not the whole picture. Sections of Chapter 4 and Chapter 7 begin to paint a picture of the various ways that engineering students and educators pushed back on oppressive systems, narratives, and scenarios they encountered during their time on the SEM4ID course. Through analysis of vignettes and reflective accounts, we can see the crucial importance of praxis for learning and emancipatory action.

There are many lessons to be learnt from the case study. I outline some of the key takeaways and recommendations below.

Lessons learnt from the SEM4ID case study

A cycle of reflection and action are critical for education for social justice

Students and staff involved in the SEM4ID course were confronted in many ways by complex demands of service learning in an international development context. Throughout Chapters 4-7, it is possible to see the journeys of struggle, and of learning and personal and professional growth amongst the students and staff. In Chapters 4 and 7, we see both students and staff awaken to and reckon with systems and structures of oppression, and wrestle with the implications of that knowledge, as they reflect on their positionality and their practice. Though students were assigned the task of critically reflecting, some educators involved in the course ended up doing their own critical reflections, as they realised that their own engineering training had not prepared them to support students on their multi-faceted learning journeys.

For the engineering educator concerned with social justice, these case examples highlight the importance of learning from and through action, but also having action be supported by learning or scholarship. The degree of personal and professional growth amongst all involved appeared to be contingent on the marrying of project-based work and critical reflection assignments. The specific orientation of the critical reflection assignment explicitly demanded of them that they engage with perspectives outside of their own. The more they were able to do so, the deeper and more nuanced their understandings of themselves and their experiences on the course became. Importantly, this assignment also required students to interrogate structures and relations of power. This is relatively rare in engineering education, though it is part of the philosophy of *praxis*, or the cycle of learning and acting on the world in order to transform it.

It is possible that SEM4ID students had the propensity for critical consciousness development since they were enrolling in a course to do “helping” work. The course seemed to help refine their ideas of what “helping” work is, and what it is not. Students seemed to wake up to the fact that the one-off engineering interventions they were working on during the course may actually be manifestations of neoliberal, neo-colonial capitalism, packaged as a “good thing,” rather than a joined-up approach that was truly empowering and uplifting for themselves or others.

Davidson, in his ethnographic study, also found critical consciousness raising amongst students - where students were in “a school environment that promoted students' internalization of an 'at-risk' status and encouraged their assumption of personal responsibility for that status” - where the internalization process seems like the “waking up” to structures, and then recognizing one’s own agency. This seemed to lead students to choose careers in public service, or mission-driven jobs, rather than individualistic, private sector jobs (Davidson, 2011).

Though the current study did not follow students as they entered the workforce after their degrees, there were a number of incidences where students reflected their intention to find work that was meaningful. Idris talked about “re-connecting” with himself after graduation. Luke discussed his desire to continue working in development, but with many new lessons and insights on Global North/South and gendered power relations taken on to inform his practice.

Yet, the style of reflection and action engendered within SEM4ID was not universally taken up. For example, Andrew was almost entirely informed by practical experience (i.e., action) when developing the SEM4ID course. His limited engagement with scholarship may have led to some fundamental weaknesses in the transformative possibilities of the course. On the other hand, students engaging in a structured scholarly environment were not necessarily able to translate insights from theory into emancipatory practice, as described in Chapter 7. That said, critical consciousness development is not a linear process, nor one that happens all at one time. That some students during the year long programme seemed to develop a heightened sense of critical awareness indicated that the various components of SEM4ID, including their reflective practice, may have provided fertile ground for this development.

Limitations to radical reformist curricula in engineering education

When I first set out to study SEM4ID, part of me expected I would be able to report on the promise of its innovative practices. The course was following what some of the most progressive engineering education researchers prescribe to cultivate engineering practitioners who are more socially and culturally conscious, and oriented to want a more just world. As mentioned earlier, Nieuwma outlines five curricular approaches that may deepen social justice in engineering: 1) the integration of liberal education courses into engineering curricula; 2) embedding social justice content into technical courses; 3) increasing critical learning thresholds around social justice through strategies such as discussion-centered teaching, small class sizes and engaging real world problems; 4) experiential learning; and 5) liberative pedagogies (Nieuwma, 2013). SEM4ID was enacting all of these approaches in various ways.

And there were many benefits to students and staff, involved. SEM4ID was an engaged space for learning and growth in multiple dimensions. The course got some students and staff thinking about their identities, their relations to histories of oppression and marginalisation, and their role in addressing those relations of power within their own spheres of control and influence.

To an extent, SEM4ID appeared to meet some of the original aims that those involved with its formation set out to achieve. Students graduated with interdisciplinary perspectives, increased skills in understanding social needs, important challenges to technological interventions over all else, and awakenings of critical consciousness. SEM4ID took learning outside of the classroom. In doing so, students and staff seemed to benefit from enhanced critical consciousness development.

This study, however, provided me a close-up view into individual and community-level relations, and through that vantage point, highlighted to me in an intimate way, how engineers interact and impact society. In Chapters 5 and 6, I provided examples demonstrating the ways in which students, staff, and their external stakeholders reproduced coloniality. The whole course was subsumed within this discourse, from the title, the orientation of the curriculum within Western modes of thought, the types of projects that students embarked on to the ways in which they engaged with “community partners.” The course reinforced modern conceptions of development, which, though challenged and critiqued, have not significantly changed since their inception.

This is not for lack of trying, great ideas, or good intentions. It is because we still exist within coloniality – a totalising force on our modern world. This includes the pervasive modern discourses of progress and development and the ways in which they form and are formed by the structure of our neo-colonial capitalist economy. Engineering, as a vehicle of colonial supremacy, became intimately intertwined with these discourses and structures. And the way that engineers are trained has not escape these factors.

In resisting the status quo within the engineering curriculum and building "social" considerations into the fabric of the course through various mechanisms, SEM4ID opened the door for students to carefully consider their social responsibility as engineers. However, in the process of critically questioning their engineering professional socialization, they surfaced ways in which their current training was reproducing not just the status quo in engineering, but the status quo for British education.

The ideology of depoliticization and meritocracy showed up in the development of SEM4ID. It was luck and intuition that brought attempts to resist the status quo into the structure of the course. If it were not for those aspects of the course, the inherent failings of the course to resist may never have surfaced. The surfacing of these failings were critically important cornerstones of my own learning about the work required to build socio-technical curricula in a way that have stronger transformative potential.

The scholarly endeavour of critical reflection is necessary, but not sufficient for transformational change. It can help deconstruct ideologies, but in order to change the world, joined up organising is necessary to change institutions and policy.

Does this all mean that we stop engaging with international service-learning projects altogether? I don't think it does. However, I do think that there need to be stronger accountability structures to ensure that decolonising frameworks and methods are implemented as a bedrock. While our institutions may be far away from adopting this as policy, it does not diminish the need for this work to occur and for the goals to become the new status quo.

Reflecting on my position

It is with time and distance from the research environment that I have been able to develop new perspectives on my own positionality. Throughout the first years of the research, I was often plagued by doubt. I began to reflect on this in Chapter 2. Upon further reflection, I recognize that my doubts and struggles were not only compounded by the research environment, but on my own insecurities in making truth claims. I am not alone in these insecurities. Entire bodies of research have emerged related to academics' identity construction, including the many challenges, conflicts, and marginalisation that can occur as one becomes an academic (L. Archer, 2008). Insecurity is understandable, particularly among “young” academics, in an academy where “questions of authenticity and legitimacy are central to the formation of the social relations within” it, “with individuals and groups competing to ensure that their particular interests, characteristics and identities are accorded recognition and value” (p. 386). Though “value” has contested meaning, it is intimately linked with power. In the neo-liberal university, those with marginalised identities often

struggle most with establishing authentic, embodied sense of value (L. Archer, 2008).

In my experience, leaning into making truth claims was a process of developing new confidence, a type of confidence that I was not (and still am not) sure that I'm entirely comfortable with. That discomfort stems from a new recognition that developed alongside it, a recognition that in interpreting data and writing this text, I wield considerable power. Making any form of truth claim, however tentative, is a powerful act. So powerful, that Foucault coined the term "power/knowledge" to demonstrate that their inextricable linkage.

Limitations of this study

This study represents my interpretations at a point in time. Though there was evolution in my thinking throughout the writing process, it is entirely possible that if I returned to my data at a later date, I would see it with a fresh perspective. I might analyse it differently and would likely draw different sets of conclusions.

With the exception of Chapter 7, which was co-produced with two key educators on SEM4ID, a further weakness was that I did not bring in informants to read my text and provide feedback on my interpretations or to co-produce interpretations of the text with a team. Therefore, this text relies on my individual, point in time, interpretation of the social scenario. Others may have read and interpreted the same interviews and observations with a completely different lens and arrive at different conclusions, as well. Future work would be strengthened by the presence of other voices within the text and interpretation.

Another limitation of this work is in some of the ways that I have positioned myself within it. At times, I position myself within the narrative as an outsider to it, giving the impression that I am positioned outside of the systems and structures that shaped the social scenario which was the focus of this research. However, a post-modern, post-structuralist perspective would assert that we are never outside of the systems, structures, discourses of our social world. Though I agree with that perspective philosophically, the practice of locating myself within those systems and structures was, at times, less of a priority to me than it was to describe and critique them. However, the absence of that self-reflexive voice throughout the text may have

had the unintended consequences of objectifying my subjects, casting my participants as objects of my observations, with me as a detached observer, rather than all of us co-producers of the social scenario, and the ways in which we all may have reproduced or resisted structures of power. Achieving the right balance between self-reflexivity and interpretive narrative was extremely challenging, and I'm not sure I got it right in this thesis.

In addition, in the writing of a "positionality statement" in Chapter 2, I have presented to the reader a story of the development of my interpretive lenses as a finite, linear narrative. This is inherently limited and limiting, as it is just one of many possible ways that I could have presented my life's learning. There is danger in presenting my "confessional tale" as a neat and tidy narrative as well - there is comfort in a beginning, middle and end. It might give off the air of ease. If anything, the process of reaching a "final product" in this thesis was anything but linear or easy. Many times over the course of writing this particular version of the thesis I was overcome with doubt and fear. But I don't intend to comfort the reader with my neat and tidy ending. This is antithetical to the work ahead. Doing anti-colonial work requires discomfort. And if I were to leave you, my reader, with a neat and tidy ending, I'm afraid I would be complicit in comforting you. "Comforting white ...discomfort not only impedes discussions around white complicity, it is also a manifestation of white complicity itself" (Applebaum, 2017, p. 866).

Another limitation is that, though my intent is to demonstrate the "contaminated" nature of my interpretive lenses, i.e. the inherently biased and subjective nature of the way I have gone about interpreting my data, I recognize that my confessional tale might be taken as a way to validate my claims to authority over the text in this thesis. Upon reflection, I cannot deny that when I initially wrote this confessional tale, I may have been trying to convince myself that I was worthy of making truth claims about my data.

There were many risks in making statements or truth claims in the creation of this text:

- 1) That I would personally offend my colleagues. This might get me into some kind of trouble. Or that I would inappropriately name and shame someone.

- 2) That I would offend the reader (a non-participant)
- 3) That my approach was inherently flawed in some way
- 4) That I wasn't making strong enough claims, that in an effort to comfort or reassure the reader (participant or not), In avoiding offending someone, I was perpetuating comforts of whiteness, and perpetuating systems of violence, injustice and oppression.

In hindsight, I can recognize this striving, this act of convincing myself, as an outward sign of my insecurities and fears in taking ownership of my claims. It may as well be a sign of a certain fragility. In avoiding making strong truth claims, and making bold conclusions, I was also avoiding making clear those systems of oppression and violence that were operating in front of my eyes. The job of the critical scholar is to lay bare those systems, which would otherwise go unseen or unsaid. If I wasn't going to do it in my own work, then who would?

Future possibilities for engineering to help

This thesis ultimately aims to make the case that current efforts to reform the engineering curriculum for a more socially responsible and just practice will continue to fall short unless we acknowledge that discourses and practices of engineering to help continue to be steeped in coloniality and continue to perpetuate modernist narratives of the need for growth and development, led by the West.

Engineering to help initiatives that are incorporated into engineering higher education programmes come packaged with directives for students to intervene in foreign lands. These programmes are often very good for students – students gain myriad skills and understanding, from cross-cultural awareness to critical consciousness raising. The communities they engage with on the other hand, most often have gained little from the interaction with students and their university sponsors.

How many more ISL projects that fail to benefit communities are needed before we consider a radical shift in the type of experience that is considered valuable for experiential learning for social justice or engineering to help?

Looking to the future of our world, we do need engineers to help us solve problems. The climate emergency is likely one of the biggest challenges humanity will ever face, and will require skilled problem solvers. Engineers are known and are proud of their problem-solving ability. But what if we've been training them to look in the wrong places for developing solutions? What if the solutions are right in front of us? What would engineering look like if it at its core involved humility, appreciation of nature and indigenous ways of being and knowing?

Decolonising efforts are making strides toward answering some of these questions. The episteme of engineering makes the work of decolonisation is even more critical and potentially even more challenging, given the historical, cultural, epistemic, and structural roots of engineering education, and how closely intertwined they are with imperialistic capitalistic interests. Again I ask, does this mean we should not try? I think we must, as resistance is key to transforming our practice for a truly sustainable and just future.

What would decolonising the engineering curriculum look like? All decolonising work must start with careful examination of ourselves and the ways in which we may reproduce systems of oppression. As demonstrated in Chapter 7, Freire's approach to *praxis* can support this work. Furthermore, *praxis* can help to reflect new understandings of history and power relations in engineering education. These updated understandings may inform new ethical frameworks and codes that engineering educators could work into the curriculum. What would engineering look like if our ethical principles involved intervention and/or extraction only as a last resort, for instance?

It might continue with an exploration of alternative philosophical standpoints from which to shape problem definition and problem solving in engineering. Ecological models, indigenous ways of being and knowing, and other subsistence forms of living may provide inspiration. Freire's conceptualisation of a liberative pedagogy provides us solid ground upon which to open ourselves to other ways of being and knowing. At the same time as we open ourselves to other epistemologies, we also must challenge positivistic ways of knowing and doing in engineering practice and education. As discussed in Chapter 2, what is considered valuable

knowledge in engineering education and EER is still shaped by positivism and technical rationality.

Decolonising possibilities have been investigated by other engineering education researchers, as well. Fomunyan (2017) explores opportunities for decolonising the engineering curriculum in a South African university through a wide-ranging survey of staff and student perspectives on the subject. The survey explored “what needs to be decolonised in engineering education, how this should be decolonised, what can enhance the decolonisation process and the implications for decolonisation” (p 6800). Notably, there was consensus that the language of engineering education – English – is a problem and a barrier for decolonising the curriculum.

Winberg & Winberg (2017) begin the development of a framework for a decolonized engineering curriculum for South African institutes of higher education. The authors developed sample traditional and “decolonized” curricula, the decolonized curricula informed by Fraser’s model of social justice and Activity Theory. They developed options for a decolonized curricula through collection of data from interviews, surveys and “fictive scripting” with multiple stakeholders, including industrial partners, students, and faculty. They amalgamated their data to formulate three options for a decolonized curriculum, which they then brought together through a “fictive script” which they propose could be used as an initial framework for curricular transformation toward decolonisation. Importantly, the authors themselves state in their conclusions that the proposed framework for a decolonized curriculum may not necessarily lead to social justice.

One major barrier to decolonising work relates to the mindsets and actions of teachers themselves. Mayberry (1998) and Riley and Claris (2009) discuss the development of critical consciousness amongst engineering faculty as a key step toward changing engineering culture via the curriculum. Throughout my field work, I noticed there were educators who did not seem aware or engaged with critical perspectives on their practice. More work is needed to unpack the viewpoints of those staff who are resistant to change.

On the other hand, this thesis illuminates stories of staff involved in the SEM4ID course seemed to critically examine their role in perpetuating power dynamics and have actively worked to shift their approach. I believe this was due to a number of factors, including the fact that the course was new, still in development and faculty were looking to improve it. In part to do with this, the faculty opened lines of communication widely with the students – they wanted feedback and created a lot of space for students to give it. I also believe it had something to do with what was surfacing through the students' critical reflection journals. It may also have had to do with my role as a critical friend in bringing new insights and perspectives to light during the evolution of the course.

Before this radical change becomes the norm, however, engineering faculty may need to additional training and resources because, the majority would have, at one point, been engineering students, trained, and socialized within the existing status quo. It stands to reason that engineering faculty, whether knowingly or not, are likely to reproduce dominant ideologies of the field, and may be sites of resistance to change in and of themselves. Indeed, there is acknowledgement in engineering education that faculty do not know how to support the development of students' critical reflexes (Epstein & Zastavker, 2017). If faculty become aware of a need for change, there are still many structural barriers, including time constraints and structural barriers that would hinder their efforts, such as those discussed in Chapter 2. In their work to develop a feminist thermodynamics curriculum, Riley and Claris acknowledge that “the biggest obstacle to implementing...liberative pedagogies is the time and energy investment” (D. Riley & Claris, 2009, p. 42). Therefore, to advance this work, an investment of time and resource is required. Training, building of communities of practice, and protected time for staff to learn are some possibilities.

Another challenge for decolonising work relates to implementation, those processual and institutional aspects of change work (Adjei, 2007). Critical pedagogy offers an important lens and process for individual level learning and action. However, it does not provide a theory of change at the institutional and structural level. Social movement theory may offer some ideas about the processes that are required to drive systemic change in our institutions, including work to build power

through collective action. Nieuwma proposes several institutional and professional targets for collective action and reform, including accreditation and changing conceptualisations of what engineering is and does through scholarship (Nieuwma, 2013).

Future Research

Future work to advance our understanding of how to create sustainable, lasting change in the engineering curriculum, with an eye toward social justice may involve longitudinal studies to track what happens when engineering graduates from programmes like SEM4ID enter engineering jobs or become engineering educators themselves. Observing the career trajectory of students would be useful to understand the reverberating impacts of a social justice-oriented engineering curriculum. Do students take their social justice education with them? In addition, work to understand the mindsets of resistant engineering educators would be useful in directing scholarship to develop more robust ways of engaging them in change. On the other hand, more stories of educators who have gone through their own transformational journeys would be useful to share with the broader engineering education research community and might help inform others' praxis. Furthermore, this thesis only begins to analyse and disentangle the ways in which neo-colonialism is embedded within the discourses and structures of our engineering institutions, curricula, and mindsets. Additional theoretical and empirical work to understand the relationship between engineering education and discourses of modernity and development will be helpful in informing change toward a more just and sustainable engineering practice. Finally, as we have learned from the many stories of those involved with SEM4ID, this work requires *action*. Research can only take us so far in building a more sustainable, just world for all.

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