Critical Engineering Pedagogy:
Curricular peer mentoring as a case study for change in the Canadian neoliberal university

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Abstract

This research explores themes of pedagogy, change, and agency within education systems, by examining the possibility of changing a pedagogical discourse within an undergraduate engineering program through critical pedagogy. Changing that discourse is necessary because engineering, as engineers themselves acknowledge, cannot remain an exclusionary space given its crucial role in shaping our postmodern world. This world is full of tensions: it is defined by a pervasive neoliberalism that values technical knowledge for its commercial utility; however, it also values human rights, social responsibility, and environmental stewardship. If engineering education only focuses on training students to solve technical problems, it risks producing engineering professionals who are unwilling to reflect on, and lack the agency to address, the effects of engineering on individuals, society, and the environment.

To address these concerns, this study piloted a peer-based learning program that ran in an undergraduate engineering program at a Canadian university for one semester, returning rich qualitative data on implementing a change process within engineering education. The pilot program was informed by critical pedagogy, and attempted to introduce a specific model of undergraduate peer mentoring, known as curricular peer mentoring, within engineering education to question exclusionary discourses. Therefore, the pilot program primarily acted as a case study into implementing a pedagogical change within engineering education at a program and faculty-level.

However, the case study was also used to assess whether introducing curricular peer mentoring within university education generally might produce graduates who are critical thinkers, and able to engage in the academic, professional, and civic discourses within and beyond their chosen fields of study and practice. This is a pressing issue of contemporary university education, for as we enter the ‘Post-Truth Era” there is an urgent need to train university graduates to think critically, so they can effectively evaluate social, political, and economic discourses.

Finally, as the wider university continues to be impacted by a neoliberal agenda that curtails their agency and shapes their pedagogies, research, and organizational structures,

they too must change. The pilot program also provided an exploration of a change process that challenges that neoliberal discourse, while at the same time existing within it.

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For my mentors:

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To Ron for opening the door,

To Tania for showing me in.

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To Cecile for opening the curtains and letting the sunlight in.

For my mother:

Thank-you for showing me the power of education. In bettering your own life, you bettered mine. I am beholden to your courage, your strength, and your ability to imagine a different life for yourself and your children. I remain in awe of your gentleness, compassion, and humour, which you bring everyday to the children you teach and whose lives you touch, just as you have mine.

To the Fates, who saw fit to entwine my thread with Scott's.

To Ngozi, my best friend.

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AUCC	Association of Universities and Colleges Canada	5
STEM	Science, Technology, Engineering, and Mathematics	6
CMS	Critical Management Studies	8
COPSE	Council on Post-Secondary Education (Province of Manitoba)	39
OCUFA	Ontario Confederation of University Faculty Associations	41
HEQCO	The Higher Education Quality Council of Ontario	42
MUN	Memorial University of Newfoundland	44
SSHRC	Social Sciences and Humanities Research Council	44
NSERC	National Science and Engineering Research Council	46
CIHR	Canadian Institute for Health Research	46
IEEE	Institute of Electrical and Electronics Engineers	69
ECAB	Engineers Canada Accreditation Board	71
PEI	Prince Edward Island	89
MIT	Massachusetts Institute of Technology	92
CBIE	Canadian Bureau for International Education	96
SFU	Simon Fraser University	117
UBC	University of British Columbia	117
UC/UofC	University of Calgary	117
UM	University of Manitoba	117
K-12	Kindergarten to Grade 12	117
SI	Supplemental Instruction	127
UMKC	University of Missouri Kansas City	127
TA	Teaching Assistant	127
PAL	Peer Assisted Learning	128
PTLT	Peer Led Team Learning	128
FYLC	First-Year Learning Communities	129
ENGI	Engineering	160
GPA	Grade Point Average	174
ID	Identification	175
UCLA	University of California, Los Angeles	187
MBTI	Myers Briggs Personality Assessment	242
PAR	Participatory Action Research	286

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CHAPTER 1: Introduction

1.1. Introduction

This research is important because it explored themes of pedagogy, change, and agency within education systems, by examining the possibility of changing a pedagogical discourse within an undergraduate engineering program through critical pedagogy[1]. Changing that discourse is necessary because engineering cannot continue to be an exclusionary space given its crucial role in shaping our postmodern world. This world is full of tensions: it is defined by neoliberalism that values technical knowledge for its commercial utility; however, it also values human rights, social responsibility, and

[1] Critical pedagogy was founded by Paulo Freire (1970) in his seminal work, *Pedagogy of the Oppressed*, which argued for the emancipatory education of historically disenfranchised peoples. Another leading critical pedagogue, Joe Kincheloe (2004) proposes the following central characteristics of critical pedagogy: (i) it is grounded on a social and educational vision of justice and equality; (ii) it is constructed on the belief that education is inherently political; (iii) it is dedicated to the alleviation of human suffering (by challenging ideological, hegemonic, disciplinary, and regulatory power dynamics that oppress individuals and groups and/or regulate a skewed social order); (iv) it prevents students from being hurt (by blaming students for their failures, measuring intelligence and ability as removed from social, cultural, and environmental factors, or denying the knowledges students bring to the classroom); (v) it is enacted through generative themes, being the relationship between any knowledges that are considered objective and the subjective perception of those it involves, as all knowledge is shaped by the context and the individuals that produce it, meaning '…contrary to the pronouncements of many educational leaders, [knowledge] does not transcend culture or history'. (p.16); (vi) it respects teachers who understand the power dynamics within education, and empowers them to be scholars that shape educational research instead of being functionaries following top-down orders; (vii) the teacher as researcher also extends to teachers studying their students to better understand and teach them, engaging in dialogue that problematizes traditional power relations so students can voice their own experiences and interrogate the larger social, cultural, and political contexts in which they live; (viii) it is interested in social change and cultivating the intellect, of teachers, students, and members of society writ large; (ix) it is interested in the experiences and needs of individuals who face oppression and marginalization, and asks teachers to include voices, texts, perspectives, and individuals who have been traditionally excluded so they can be heard; (x) it recognizes the power of positivism and post-positivism, and critiques it and the effect it has had on education content and systems; (xi) it is aware that science (particularly social, behavioral, and educational) can be used to regulate and control individuals and groups, so the knowledges they produce must be examined in the context of the social, cultural, and historical contexts in which they were/are produced; (xii) it understands there are various contexts for learning; (xiii): it recognizes and values the complexity of epistemologies in constructing critical education; (ixv) most importantly, critical pedagogy resists dominant power, exposing and contesting oppressive forms of power as socio-economic elitism; and (xv) it avoids empire building and rejects neocolonialism (Kincheloe, 2004, pp. 1-43).

environmental stewardship. If engineering education continues to be focused on training students to solve technical problems, it risks producing engineering professionals who are unwilling to reflect on, and lack the agency to address, the effects of engineering on individuals, society, and the environment.

Furthermore, as the wider university continues to be impacted by a neoliberal agenda that constrains their agency and shapes their pedagogies, research, and organizational structures, they too must change. Nevertheless, the pressures that are placed on them by government, industry, and students themselves, to produce employable graduates, cannot supersede their responsibility to educate a critical citizenry. As we enter what academics and political commentators are calling the 'Post-Truth Era" (Harsin, 2015; Keyes, 2004; Krugman, 2011; Sambrook, 2012) there is an urgent need to train university graduates to think critically[2], so they can effectively evaluate social, political, and economic discourses. Unfortunately, research shows that the goal of educating a critical citizenry, the foundation of democratic society, remains unrealized, as "…far too many students lack the knowledge, beliefs, skills, and strategies required to think critically and analytically" (Alexander, 2014, p. 470; Arum & Roksa, 2011).

This study piloted a peer-based learning program that was informed by critical pedagogy, and attempted to make a specific change within engineering education to combat

[2] Critical thinking is a "…purposeful, self-regulatory judgment that results in interpretation, analysis, evaluation, and inference, as well as explanations of the considerations on which that judgment is based." (Abrami, Bernard, Borokhovski, Waddington, Wade, & Persson, 2015, p. 275). It requires epistemic cognition: the ability to construct, evaluate, and use knowledge (Green & Yu, 2015, p. 45). Research into effective strategies for teaching critical thinking skills include "…dialogue, the exposure of students to authentic or situated problems and examples, and mentoring." (Abrami et al., 2015, p. 275).

exclusionary discourses, while assessing whether this could be extrapolated to promote a general change within university education to produce critical thinkers[3]. The pilot ran in an undergraduate engineering program at a Canadian university for one semester, returning rich qualitative data on implementing a change process within university education. Given the neoliberal constraints on universities and their faculties and programs, the pilot program also provided a case study for exploring change processes that challenge these discourses, while at the same time existing within it.

1.2. Background to the Research Problem

An inescapable neoliberal paradigm has come to characterize the 21st century (Chomsky, 1999; Giroux & Cohen, 2014; Turk, 2010). Privatization of formerly public institutions is the norm, government deregulation of important public goods and services is standard practice, as is the outsourcing of publicly owned services to private businesses. Fiscal austerity is the go-to response during economic downturns, and reductions in government spending on public services, institutions, and infrastructure, have become regular features of economic policies. In Canada, this marketplace logic dominates federal and provincial education policy (Turk, 2014), and despite having an important civic responsibility to interrogate this neoliberal discourse, Canadian universities have, arguably, been subsumed by it (Stanford, 2014).

[3] The previous footnote refers to a leading definition of critical thinking that was developed by a panel of 46 experts, and organized by the American Philosophical Association, who also define the ideal critical thinker as "…habitually inquisitive, well-informed, trustful of reason, open-minded, flexible, fair-minded in evaluation, honest in facing personal biases, prudent in making judgments, willing to reconsider, clear about issues, orderly in complex matters, diligent in seeking relevant information, reasonable in the selection of criteria, focused in inquiry, and persistent in seeking results which are as precise as the subject and the circumstances of inquiry permit." (Abrami et al., 2015, p. 277; Facione, 1990, p.2).

Under neoliberalism, university education is valued because it educates students to develop the practical skills necessary to be productive employees within an information society (Davenport, 2001; Harpham, 2011); they are the future highly-educated workforce Canada needs to be successful in the knowledge economy[4]. This utilitarian view of university education has been made explicit through government policies (Advisory Panel on Canada's International Education Strategy, 2012; Government of Canada, 2016; Senate of Canada, 2011), that reduce university graduates to their economic utility (Council of Canadian Academies, 2009; Hull, 2005). The arguments being made by the provincial and federal governing bodies in Canada (Foreign Affairs, Trade, and Development Canada, 2014; Government of Alberta, 2013; Ontario Ministry of Training, Colleges and Universities, 2016), reflect similar arguments being made across the West about the value of university education, and the university as an institution, being linked to its role in the market (Davies & Peterson, 2005; Davies, Gottsche, & Bansel, 2006; Neave, 2006).

At the same time universities are responding to the challenges of neoliberalist policies, meaning they are underfunded and understaffed (CAUT, 2015a), they have also become oversubscribed (CAUT, 2015b). There are growing numbers of students entering university programs. Domestic university student enrolment has seen sharp increases within the last decade alone – 1,758,591 domestic students were enrolled in the 2010/2011 academic year up from 1, 295, 643 domestic students in 2000/2001, with

[4] The “Knowledge Economy” is a term used by academics, policy-makers, business leaders, and social commentators to describe an economic structure that relies on intellectual capabilities over physical or natural resources. Powell & Snellmam (2004) define the knowledge economy as “production and services based on knowledge-intensive activities that contribute to an accelerated pace of technical and scientific advance, as well as rapid obsolescence.” (p. 199).

international student enrolment tripling to 146, 928 during the same time span (Statistics Canada, 2012). As of 2011, 16.5% of Canadians held a bachelor degree, 5.1% held a master's degree, and 0.9% held a doctoral degree (Statistics Canada, 2011a, p. 8). [5] Given the perception of university education as a route to well-paid employment, which is another example of how neoliberal thinking has impacted education, the numbers of young people entering university are expected to grow (Brock, 2010; Senate of Canada, 2011).

Furthermore, this influx of students is bringing new learners into an old system (AUCC, 2011). Many of these new learners have been historically excluded from higher education, such as women, socially disadvantaged, racialized[6], and Indigenous[7] persons, and should be offered additional resources and support to help them navigate a university hierarchy that has historically privileged white, Western[8], heterosexual, middle and

[5] Statistics Canada releases the 2016 Census data on Education on November 29, 2017 (http://www12.statcan.gc.ca/census-recensement/index-eng.cfm).

[6] Racialized is a term that refers to "the process through which groups come to be socially constructed as races, based on characteristics such as race, ethnicity, language, economics, religion, culture, politics, etc. That is, treated outside the norm and receiving unequal treatment based upon phenotypical features." (CRRF, 2017). "Racialization is an ideological process, an historically specific one. Racial ideology is constructed from pre-existing conceptual (or, if one prefers, "discursive") elements and emerges from the struggles of competing political projects and ideas seeking to articulate similar elements differently" (Omi & Winant, 1994).

[7] "Indigenous is a term used to encompass a variety of Aboriginal groups. It is most frequently used in an international, transnational, or global context. This term came into wide usage during the 1970s when Aboriginal groups organized transnationally and pushed for greater presence in the United Nations (UN). In the UN, "Indigenous" is used to refer broadly to peoples of long settlement and connection to specific lands who have been adversely affected by incursions by industrial economies, displacement, and settlement of their traditional territories by others." (First Nations & Indigenous Studies, 2009). Throughout this thesis, the 'Indigenous' will be capitalized as a sign of respect to the people I am referring to.

[8] The term 'Western' refers to persons whose cultural history and contemporary worldview is predicated on a historical and theoretical framework influenced by European civilizational identify formation, which followed the break-up of medieval Christendom and the discovery and colonization of the Americas during the sixteenth and seventeenth centuries. This conceptual framework has been used by Europeans and North Americans to conceive of and manage their worlds throughout the past 500 years, and has led to the colonization of peoples within and without Europe and North America whose worldviews did not reflect the ideals of the European Renaissance, Enlightenment, Industrial Revolution, or Modernity (i.e. the modern

upper-class men (Freire, 1994; Giroux & Giroux, 2004; hooks, 1994) Therefore, even though it may participate in, or perpetuate, limiting discourses, I argue in this thesis that university education must not be bound by those discourses or reduced to its economic utility, because it has a responsibility to its students and society to challenge economic, political, and social discourses that disempower individuals through discrimination or do not serve the public good (Giroux, 2004; McLaren & Farahmandpur, 2005).

1.3. Research Problem

Neoliberalism is profoundly changing the nature and intent of university education. While Canadian universities respond to changing rationales and expectations of what higher education should be, they must also be responsive to the needs of social minority groups, such as racialized domestic and international students, Indigenous students, and women in disciplinary areas largely dominated by men, such as Science, Technology, Engineering, and Mathematics (STEM) disciplines. While universities address shifting student demographics, they must also maintain a focus on important learning outcomes – such as students who can think, read, and write critically, are literate and numerate across the curriculum, and have a broad knowledge base (Harpham, 2011). These important education outcomes become harder to deliver, however, as the university becomes increasingly pressured to realize neoliberal objectives, wherein education is seen to serve the market.

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western intellectual tradition). (Baker, 2012). Therefore, the term 'Western' can also be considered 'Euro-American', 'Occidental', and/or 'Eurocentric', and refers to a narrow set of philosophical assumptions about the world, initially constructed by European men.

While much research has been conducted on critical pedagogy (Kapitulik, Hilton, & Clawson, 2007; McArthur, 2010b; Mills, 2007), as well as neoliberalism (Barbour, 2016; Cannella & Koro-Ljungber, 2017; De Leo, 2017; Giroux & Cohen, 2014; McLaren & Farahmandpur, 2005) and discrimination within university education (Broido, Brown, Stygles, & Bronkema, 2015; Hutcheson, Gasman, & Sanders-McMuty, 2011; Johnson, Pizzolato, & Kanny, 2015; Nadal, 2014; Suoranta & Olli-Pekka, 2006), little is known about how critical pedagogy can be used to change neoliberal and discriminatory practices in university education. Indeed, this is a significant gap in the literature on critical pedagogy (McArthur, 2010a; McClaren & Kincheloe, 2007), which a leading thinker in the field, Henry Giroux summarizes quite starkly:

> Radical educators have abandoned the language of possibility for the language of critique. By viewing schools as primarily reproductive sites, radical educators have not been able to develop a theory of schooling that offers the possibility for counter-hegemonic struggle and ideological contestation…radical educators have failed to develop a language that engages schools as sites of possibility, that is, as places where particular forms of knowledge, social relations, and values can be taught in order to educate students to take a place in society from a position of empowerment rather than from a position of ideological and economic subordination (Giroux, 2004, p. 199).

This study attempts to offer a possibility for counter-hegemonic struggle by taking an interdisciplinary approach that combines education literature about learning, with management literature about change, to create a student-centered pedagogy that empowers students to be critical thinkers, while accounting for the changing university learning environment and its diminished institutional resources. In doing so, this study also adds to the management literature because it explores how pedagogical theory can be used to facilitate organizational change. It also adds to the education literature by examining how people respond to change; change being one of the *raison d'être* of education.

By combining these two literatures, this study explores what a 'new language of possibility within higher education' might be, viewing it as one that challenges the neoliberalist discourse through critical pedagogy. Therefore, although this study appeals to certain parts of the management literature on change, it is very much rooted in critical theory[9]. A neoliberal argument would hold that is important for universities to develop pedagogy that is responsive to the contemporary knowledge economy by educating students to have the knowledge and skills necessary to be successful beyond academia, and that this must be done at the lowest possible cost.

The argument being made in this study, however, is that despite the constraints of neoliberalism on Canadian universities, it is possible to make changes within these limitations that retain the integrity of university education by employing critical

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[9] Although there is a field of critical theory called "Critical Management Studies" or "CMS" it is criticized by critical theorists researching outside the CMS field as serving a managerialist, not emancipatory agenda. Klikauer (2015) summarizes this perspective as follows: *"CMS views itself merely as a 'study', not as an academic, theoretical and, above all, philosophical discipline…CMS remains a 'study' inside managerial infrastructures, frameworks, paradigms, and ideologies. Critical theory is the exact opposite. It only exists for itself, serving nobody – with the exception of those oppressed – but least of all management and managerialism."* (p. 205). Therefore, this stream of critical theory was not explored in relation to change, despite this study referring to management literature on change in establishing its theoretical framework.

pedagogical interventions that utilize student-centered teaching and learning methods. This study argues that the integrity of university education lies in its power to educate graduates to be critical thinkers, as "…one long-held belief shared by educational researchers, practitioners, policymakers, and the general populace is that schools and society benefit when individuals or groups are perceptive and attentive to the world around them and manifest the ability to think deeply and flexibly about important issues, that is, when they think critically and analytically." (Alexander, 2014, p. 470). It holds that critical pedagogical interventions, that use research proven methods, such as dialogue, mentoring, and problem-posing (Byrnes & Dunbar, 2014), can foster that critical thinking process. Finally, this study contends that critical process is most effectively undertaken through student-centered learning because that empowers the individual learner to explore their own ideas and experiences, ask their own questions, and to find their own answers, which is the foundation of critical pedagogy (Freire, 1970). Moving away from a teacher-centered education paradigm removes power from the educational authorities so students can "…explore alternate sources, compare diverse historical interpretations, do research of their own and produce knowledge that may conflict with prevailing interpretations." (Kincheloe, 2004, p. 9).

1.4. Conceptual Framework

Understanding student-centered teaching and learning methods first requires defining learning. Contemporary notions of learning view education as an active process of teaching people how to think about the content of what they are learning, and assisting them in adapting, organizing and communicating what they have learned (Corrigan, 2012;

Fosnot, 2005; Golding, 2011). Therefore, learning is not located in the repetition of factual knowledge, or even a facility in understanding or applying that knowledge – it is in the ability to analyze information, evaluate it, and then generate new knowledge (Bloom, 1956; Krathwohl, 2002). This definition of learning stems from constructivism, which is a specific philosophy about human intellectual development.

Constructivism holds that: (i) knowledge is not passively accumulated, but rather, is the result of active cognizing by the individual; (ii) cognition is an adaptive process; (iii) cognition organizes and makes sense of one's experience; and, (iv) *knowing* has its roots in both biological and neurological functions, as well as social, cultural, and language based interactions (Doolittle, 2003). It is a learning theory that originates in cognitive science, which broke sharply with the early 20th century psychological perspective on learning offered by behaviourism, which holds that the cause of human behaviour cannot be accounted for by beliefs, emotions, attitudes, or values, seeing it as purely a result of that which is external to the mind and therefore able to be empirically understood (Doolittle, 2003; Graham, 2010; Mandler, 2002). Constructivism is a theory of mind aligned with postmodernist assumptions about knowledge being subjective, whereas behaviourism assumes knowledge is objective. Both theories of mind, therefore, reflect the dominant philosophical paradigms of their time.

Given this, constructivism is often set up in opposition to behaviourism, and this is reflected by different epistemologies of learning: rote learning and meaningful learning. Rote learning is informed by empiricism – knowledge is considered non-partisan, quantifiable, and testable – it is not tied to affective states, intuition, or interpretation

(Creach, 2011; Wierzbicka, 2011). Rote learning is still widely employed within the STEM disciplines (Singer, Neilsen, & Schweingruber, 2012), and prominent engineering educators calling for change, such as Goldberg and Somerville (2015), characterize much of traditional engineering teaching and learning methods as a rote learning exercise (Miller, 2014)[10]. However, meaningful learning is possible within engineering education, and would be a useful method of instruction, as it connects new knowledge to knowledge the learner already has, building on their previous experience (Mayer, 1999; Novak, 2011; Novak & Canas, 2008). This type of learning within engineering is strongly advocated by progressive engineering educators (Ballie & Catalano, 2009b; Catalano, 2009; Grasso & Burkins, 2010; Goldberg & Somerville, 2014; Miller, 2014) who are concerned with connecting the technical knowledges engineers acquire to the social complexities in which those knowledges exist and are applied. The former is widely understood to be a teacher-centered learning approach to learning, the latter to be a student-centered approach, because it views the construction of meaning as individual to each learner (O'Neill & McMahon, 2005, p. 29).

Student-centered learning breaks away from the traditional model of university teaching or “instruction paradigm” by creating “environments and experiences that bring students to discover and construct knowledge for themselves, to make students members of communities of learners that make discoveries and solve problems” (Barr & Tagg, 1995, p. 17). Learning is conceived as a collaborative activity, with discussion, feedback, and guidance, assisting students to make connections between their individual experiences

[10] There has been a push by engineering accreditation boards and governing bodies to address this, with mixed results. Refer to Chapter 2.6: Engineering Education for further discussion.

and thought, to factual knowledge or theoretical constructs (Garrison & Arbaugh, 2007; Novak, 2011). Despite efforts to promote a student-centered learning approach to university education (Barr & Tagg, 1995; Biggs, 1996; Chickering & Gamson, 1987), many universities still employ a transmission-model lecture format and a predominantly rote-learning approach (Hornsby & Osman, 2014), especially within the large lecture halls common among junior undergraduate classrooms (Allais, 2014; Exeter, et al., 2010). It is difficult to employ a constructivist, student-centered approach in these large classes, and research has shown large classes have adverse effects on student motivation, engagement, and commitment (Cuseo, 2007; Ehrenberg, 2001). Furthermore, large class sizes negatively impact students' ability to develop critical thinking skills (Exeter, et al., 2010; Mulryan-Kyne, 2010).

Large lecture halls, however, provide economies of scale, which are necessary in the current global higher education environment. Access to higher education has expanded substantially: In 1900, only 500,000 persons, which was a fraction of a per cent of the global population, were enrolled in, or had completed, tertiary education (Schofer & Meyer, 2016). By 2,000 this jumped to approximately 20%, and many countries now have more than 50% of their population enrolled in some form of tertiary education (Schofer & Meyer, 2016). Canada is no different: by 2014, 54% of its population aged 25-64 had completed tertiary education, and as of 2015, 59% of its population aged 25-34 held a qualification equivalent to a 2-year degree or higher, 34% held one equivalent to a 4-year degree or higher, and 9% held one equivalent to a 6-year degree or higher (OECD, 2017). Despite this boom in student enrolment, public funding to Canadian universities has been cut in half within the last two decades (CAUT, 2012b). Subsequently, universities have been forced to cut expenditures on academic salaries (CAUT, 2012a). This affects the quality of university education because it increases the student-faculty ratio (Davenport, 2001; Maringe & Sing, 2014) and many scholars argue this, coupled with a higher reliance on contractual instructors, has led to an overall decline in undergraduate learning outcomes (Arum & Roksa, 2011; Clark, Van Loon, & Trick, 2011; Green & Riddell, 2012).

Responding to the budgetary pressures universities are under by reducing teaching staff and increasing class sizes is not advantageous for university learners, yet it is a reality that exists. One possible solution to both issues – declining teaching quality and budgetary pressures – could be curricular peer mentoring. Curricular peer mentoring is a student-centered learning program that places senior students in university classrooms to mentor their junior peers (Smith, 2008). Studies suggest that academic support which is embedded directly into the classroom is advantageous to student learning outcomes because it is not removed from a student's course materials and work, and does not run the risk of stigmatizing students who need additional support (Arendale, 2004). This study argues it can also cut down costs associated with running academic support programs by centralizing the administrative support for the program. Therefore, curricular peer mentoring may support the intellectual rigour of university programs and the educational attainment of university students through a student-centered learning approach that does not tax limited university resources. Simply put, curricular peer mentoring may be a way to support universities and their students despite the limitations of neoliberal institutional practices.[11]

1.5. Research Purpose

The purpose of this research was to adapt a specific curricular peer mentoring model used at the University of Calgary for use at another Canadian university to test its transferability to another institution and faculty, and in service of different educational goals. This study therefore documents and analyzes a case study of a pilot curricular peer mentoring program introduced in a Faculty of Engineering at Maple University[12], a medium-sized post-secondary research institution in Canada, which aimed to utilize curricular peer mentoring as a critical pedagogical intervention to change university teaching and learning practices and support a diverse student body, while operating within neoliberal constraints.

This case study was not only assessed for its ability to respond to the above concerns, but also as an intervention meant to promote institutional change in general. Therefore, the case study examined whether curricular peer mentoring could act as a catalyst for change within a specific university faculty, by analyzing the reactions from stakeholders within that faculty to this change initiative. The data collected from these stakeholders provided insight into how university institutional culture can affect whether new programs or initiatives fail or succeed.

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[11] The advantage of curricular peer mentoring in a neoliberal paradigm is its ability to be 'sold' as a cost-reduction program. However, it has proven benefits for the peer mentors, because they are able to profoundly engage in their own program of study, deepen their pedagogical knowledge, and develop interpersonal skills (Smith, 2008). Its use in this study is solely aligned with this critical/emancipatory perception of peer mentoring.

[12] Maple University is a pseudonym. The name of the university has been anonymized to protect the identities of research participants.

Therefore, there are two components to this research project: *an **intervention***, being the application of curricular peer mentoring within an engineering undergraduate program, and an ***assessment*** of that intervention for its efficacy in meeting specific educational and institutional change goals. Both components are discussed in relation to three themes foundational to the research project: *pedagogy, change, and agency*.

1.6. Research Questions

1) Could curricular peer mentoring be utilized as a critical pedagogical intervention to:

   a) change the Faculty of Engineering teaching and learning practices?
   b) meet the needs of diverse students?
   c) minimize the costs of student academic support?

2) Can curricular peer mentoring enact institutional change by addressing the needs and concerns of university education?

1.7. Organization of Thesis

Given the layered nature of the case study, I have adopted an interdisciplinary approach to describing and understanding the research site, and for analyzing the research data. Pedagogy, change, and agency are three themes underpinning the development of the curricular peer mentoring intervention, and are also brought to bear in its assessment. Pedagogy refers to university teaching and learning theories and practices, change refers to the individual and institutional responses to a shifting internal and external university environment, and agency refers to the capacity of individuals and institutions to act in response to changes taking place within and around universities. These themes are discussed in relation to one another and the research study, throughout this thesis.

The theme of pedagogy informs the discussion of contemporary Canadian universities and the social, political, and economic contexts in which they currently exist. This discussion helps contextualize the nature of university teaching and learning, and speaks to the theoretical foundation of the curricular peer mentoring program intervention. Pedagogy also underpins the discussion of engineering education, along with discussions about racism and gender disparity in science, technology, engineering, and mathematics (STEM) disciplines. The theme of pedagogy also relates to the content and delivery of the curricular peer mentoring program, which was the vehicle for the case study. Therefore, the theme of pedagogy was important in situating and setting up the intervention.

The theme of change informs the discussion of Canadian universities, and where they are today in terms of their internal activities and practices, as well as their external environment. The theme of change was also present in the design of the case study, as being responsive to the institutional context in which the case study operated necessitated understanding the changing university institutional environment. The theme was also explored in analyzing how institutions change, barriers to that change, and how to manage change. Finally, the theme of change was also important to analyzing what happened in the case study and whether change happened.

The theme of agency is predominantly linked to the theme of change, as without agency there can be no change. Agency, as related to the power of universities to set their own institutional objectives and programs was a significant discussion, but so too was agency at the individual level. The agency of individual research participants involved in the study, including myself as the program developer, was particularly highlighted.

1.7.1. Literature Review

The following chapter provides a comprehensive literature review of the effects of postmodernism and neoliberalism on university education, and looks specifically at how these two paradigms have impacted Canadian universities. Change, and how it applies to university organizational structures is then briefly examined, which leads into a discussion of critical pedagogy and engineering pedagogy, and how they can be combined to create a ‘critical engineering education’ through curricular peer mentoring. These discussions bring together education and management literature, to offer new frameworks for thinking about change processes, and education systems and methods. The discussion also highlights the necessity for a ‘language of possibility’ within higher education, and proposes a theory of schooling that might empower students and their teachers to counter neoliberal hegemony.

1.7.2. Methodology

In Chapter 3, I discuss the methodological framework in which my research was situated. I begin by discussing qualitative case studies generally, and my decision to use a praxis-oriented case study method grounded in a basic qualitative study research design. Using a case study methodology enabled me to collect rich, qualitative data from numerous university stakeholders involved in the change introduced by the curricular peer mentoring intervention. Having detailed data from various stakeholders participating in, or affected by the research study, allowed me to comprehensively answer my research questions because I could capture all individual and organizational responses to the change process.

After providing this rationalization, I introduce the case study site, and discuss the barriers I encountered to locating a suitable research site. I then detail the research populations I targeted in my study, my data collection methods, and introduce my research phases, which organize the data and resultant discussion. Finally, I briefly discuss my role as a researcher.

1.7.3. Data Chapters

In Chapter 5: Phase I: Intervention, I introduce the first of two data chapters. I discuss the initial research phase that my study progressed though. Phase I was about the peer mentoring *intervention* and was concerned with setting up the pilot seminar course and instructing the peer mentors in the seminar course designed specifically for supporting them in, and teaching them about, their mentoring role. Data collected from this phase included document analysis and researcher observations. Documents analyzed included correspondence between myself and select research participants, and various course documents produced by the mentors within the curricular peer mentoring seminar course. Researcher observations were based on my own observations setting up the intervention, liaising with research participants, and teaching the curricular peer mentors.

In Chapter 6: Phase II: Assessment, the research is concerned with *assessing* the intervention. The goals of this phase were to understand the mentee and mentor experience of the pilot program, as well as investigate the efficacy of the curricular peer mentoring intervention as a vehicle for institutional change within the engineering faculty. Accordingly, the data collection activities were more varied, and included survey responses returned by student mentees, engineering faculty and staff, as well as interviews with the key administrators, host instructors, and mentors. Document analysis was again used to analyze coursework returned by the curricular peer mentors.

1.7.4. Conclusion

In Chapter 7, I revisit the three themes of pedagogy, change, and agency to discuss how they relate to my data results. I reflect on the environment in which contemporary universities are situated, the students they educate and the teachers who provide that education. I question how universities currently educate students, and whether the changes in educational provision and programming offered by a peer-based learning framework has the capacity to respond to stakeholder demands while facilitating the critical potential of university learning. I also discuss the readiness for change universities currently demonstrate, and how the need for change is pressing for their long-term sustainability.

1.8. Conclusion

This chapter introduced the research study, arguing for the establishment of a 'critical engineering education', given the impact engineers have on individuals, society, and the environment. It linked that to the effects of neoliberalism on universities in general, and the constraints that places on critical education. It then proposed curricular peer mentoring as a possible method to address the effects of neoliberalism on university education, and act as a vehicle for critical pedagogy. A brief background of the effects of neoliberalism on Canadian universities was then given.

Following this, the research problem was introduced, highlighting the main knowledge gap this study addresses, being the failing of critical pedagogy to provide solutions to the problems it has identified in education systems. From there, the conceptual framework provided a review of different learning theories within higher education, and argued for a critical pedagogical approach to university teaching and learning. The research purpose introduced curricular peer mentoring, a student-centered pedagogy adapted for use in this study, as a critical pedagogical intervention that could possibly change engineering undergraduate education at a Canadian university. The research questions were then posited, and the themes of pedagogy, change, and agency were detailed. Finally, this chapter ended with an overview of the remaining thesis chapters and content.

The following chapter offers a comprehensive literature review of the postmodern university, the postmodern university and neoliberalism, the postmodern university and change, pedagogies for change, engineering education, and critical engineering education through curricular peer mentoring.

CHAPTER 2: Literature Review

2.1. Introduction

In this chapter, the university is discussed in terms of how it is affected by two oppositional theories that underpin contemporary society: postmodernism and neoliberalism. Postmodernism has disrupted historical ideas about the nature of reality, and opened new debates that critically question established assumptions about what it means to create knowledge (Foucault, 1982). Essentially, postmodernism has brought subjectivity to the forefront of what it means to research, to teach, and to learn, challenging long held assumptions about the university and its activities. At the same time, it has affected the larger society in which the university exists. Traditional social hierarchies that privileged certain genders, ethnicities, and cultures over others, have been called into question (Bilimoria & Stewart, 2009; Pio, Rasheed, & Parker, 2014; Poolokasingham, Spanierman, Kleiman, & Houshmand, 2014). It is no longer possible for the university to deny women and/or people of colour and/or Indigenous persons, access to a university education (Baker, 2012; Senate of Canada, 2011). Nor is it appropriate for certain university disciplines, such as engineering (Cech, 2014; Mayes, 2014), to perpetuate a culture of exclusion against such persons.

While universities and its members respond to these multifaceted challenges to its established ontology, epistemology, axiology, and historic institutional culture, it is also being pressured by government and industry to respond to a neoliberal ethos that views public institutions as vehicles of economic activity that should ascribe to capitalist structures and conclusions (Giroux & Cohen, 2014). On the one hand, this has benefitted people traditionally excluded from the academy, because the pressure universities are under to corporatize means they must increase student enrollment. Unfortunately, however, this neoliberal influence also positions the university as a service provider, with universities expected to prioritize enrolling students and ensuring they have a good university 'experience' rather than a good education (Carlson & Blumenstyk, 2012). This impacts the quality of university education because many of the people instructing North American university courses are underpaid, contractual staff (Basen, 2014; Field, Jones, Karram Stephenson, & Khoyetsyan, 2014), who are often highly qualified and exceptionally strong teachers, who must teach while contending with the stresses of precarious employment, little to no employee benefits, little to no time to pursue academic research, and constantly in the process of applying for their own contractual jobs term to term, putting forward applications for tenure-track positions, and writing funding and grant applications.

Moreover, the outcomes of a university education are explicitly market-driven, with university students expecting their degree will guarantee them a job (Baum, Ma, & Payea, 2010). Considering how costly a university education is, given the constantly rising tuitions fees that universities must charge to cover inflated operating expenses incurred from their ever-increasing administrative offices and extracurricular attractions, it is not surprising that students want 'value for their money'. Indeed, it is understandable that they might have this expectation given the pervasiveness of neoliberalist thought in contemporary society, which monetizes university education and positions it as a transaction between student (consumer) and university (producer) (Cannella & Koro-

Ljungber, 2017). Even if critiques are voiced, it has become harder for universities or their members to question neoliberal motives and activities because their autonomy continues to be curtailed by government intervention and industry pressure (Davies & Peterson, 2005).

Given these pressures, the university finds itself in a hard place. Turk (2010) argues that because its public funds are being extensively cut, it is being forced to operate as a commercial enterprise. Therefore, universities must make tough decisions about how they can best support themselves amidst a society that is driven by market ideology, a result of the 'knowledge economy' whereby "…knowledge production is organized primarily around its economic relevance for facilitating process of neoliberal marketisation and commodification (Canaan & Shumar, 2008). For many academics, there is a view that university education has become dominated by market-place logic (Bourdieu, 1998; Canaan, 2008; Canaan & Shumar, 2008; Cannella & Koro-Ljungber, 2017; Chomsky, 1999; Davenport, 2001; Davies & Peterson, 2005; Davies & Gottsche, 2006; Franklin, 2000; Harpham, 2011; Giroux & Cohen, 2014; Rhoads & Slaughter 2006; Shumar, 1997; Slaughter & Leslie, 1997; Stanford, 2014; Turk, 2010; Wright, 2004;). Indeed, Boron (2006) refers to this as a 'bizarre idea' – "…that universities should be regarded as money-making institutions able to live on their own income.' (p. 149). Turk (2010) argues that this turn towards marketplace logic is not only seen in the commercialization of university education provision, but also the commercialization of university research. Again, this is something that the university can only resist so much, and for so long, as government research funds become more targeted towards market-driven research projects and industry partnerships.

This chapter therefore breaks down the various effects of postmodernism and neoliberalism on the university, and questions how the university can change in response to these tensions. In doing so, it asks how the university can retain the best of these effects, such as answering the call for diversity and inclusion, through critical pedagogies that facilitate postmodern objectives while being responsive to the neoliberal pressures on the university. The three themes of pedagogy, change, and agency introduced in *Chapter 1: Introduction*, will be referred to throughout this chapter, situating the discussion in the overarching conceptual framework that has informed this research project.

In the first section of this chapter, *The Postmodern University*, the contemporary university is defined, and the tensions universities face when navigating the expectations of a postmodern society while responding to neoliberal institutional outcomes are discussed. The second section of this chapter, *Neoliberalism & The Postmodern University*, provides a detailed overview of the present-day reality of Canadian universities, including their loss of autonomy, their reliance on contractual staff and international student tuition to offset operating expenses, and their continued commercialization. The third section of this chapter, *Change and the Postmodern University*, provides a brief overview of change management theory as it applies to university institutional environments. The fourth section of this chapter, *Pedagogy for Change*, argues critical pedagogy is a vehicle for change, focusing on its application to undergraduate engineering education, as the case study implemented as part of this research project is situated in a university engineering faculty. The fifth section of this chapter, *Engineers, Education, and Equity* expands on the discussion introduced in the previous section, and discusses systemic issues with inclusivity in engineering education and the profession. The sixth section of this chapter, *Building Inclusive Engineering through Curricular Peer Mentoring*, introduces curricular peer mentoring as a pedagogy for change, providing a historical overview and examples. The chapter concludes by synthesizing these topics, bringing pedagogies for change to bear as the postmodern university responds to neoliberal influences.

2.2. The Postmodern University

It is important to understand postmodernism because Canadian universities exist in a complex environment. The practice of teaching and learning in higher education is shifting in response to the sheer numbers of students pursuing university education (AUCC, 2011), the public sentiment about what a university education should provide – being a technical or professional skill set (Brown, 2011) – and government and industry demands for commercially-driven research and university students that are ready for employment upon graduation (Davenport, 2001; Giroux & Cohen, 2014; Noble, 2000).

As enrollment numbers increase universities are working to accommodate student needs, and those of other relevant stakeholders, as government funding dwindles, and they increasingly fund their own operating costs (CAUT, 2015b). Often, funding is sourced through methods that are directly in conflict with maintaining the integrity and autonomy of the university (Franklin, 2000). In this demanding environment, delivering education is challenging, as Canadian universities are contending with difficult realities: a greater student-teacher ratio, which has arguably amplified the reliance on adjunct faculty, an increasing loss of autonomy in face of government intervention, and the continued commercialization of the university, which can affect its educational mandate and research horizons (Turk, 2000).

Essentially, universities are caught between two diametrically opposed manifestations of the postmodern period. On one hand, they are being asked to facilitate the postmodern ethos of social equity by being more inclusive and diverse in whom they educate, who provides that education, and what education encompasses, by facilitating universal access for learning, and providing a learning experience that speaks to each student as a unique individual. On the other hand, they are being asked to align themselves with neoliberal ideologies, thereby positioning the university as a vehicle purely for economic gain and subject to external intervention by government and industry.

The strategies that universities are using, or in some cases being pushed to use, are not effective for meeting the first objective, and compromise the long-term efficacy of the university in meeting the second expectation that it be profitable. These strategies, such as the use of contractual teaching staff, aggressive enrolment of international students, industry-directed research projects, and managerial organizational practices, are also contributing to a loss of institutional autonomy that is impacting the ability of universities to be responsive to the complex social, political, and economic environment in which they exist. Furthermore, at a time when change is ever-present within and without the university, discourses of change are emblematic of neoliberalism which can operate under the assumptions that organizations must be economically productive, and that productivity can be found or enhanced through managerialism. Universities need to use strategies that take an interdisciplinary approach, building on the strengths of education literature to design effective educational programs while also applying management literature on change, to proactively respond to its current social, political, and economic environments.

Change within the university must also assume a critical approach when connecting the management literature on change to education research, so it not only responds to the constraints of neoliberal pressures, but can possibly subvert them. Enacting change through a critical pedagogy framework that empowers students, educators, and administrators, can be an important counter-hegemonic tool for universities wrestling with a loss of autonomy over their institutional practices, mandates, and directions. Arguably, this is most important in professional education programs such as engineering, which are even more deeply influenced by neoliberal objectives than other university disciplines simply due to the nature of their mandate, which is to educate people for a specific job and skillset. Peer-based learning, particularly curricular peer mentoring, is a strategy that university administrators and faculty can use to provide an inclusive, critical, and empowering learning experience for students within a neoliberal social, political, and economic paradigm.

2.2.1. Postmodernism: A Definition

Postmodernism is both a theoretical perspective, and a historical period (Boland, 1995). As a theory, it is "a form of analysis associated with post structuralism and deconstruction that brings to the fore the place of language and discourse and that challenges foundational certainties in thought and action" (Lemert, as cited by Edwards & Usher, 2001, p. 274). In terms of its characterization as a historical period, it runs from the late 20th century through to today and has two predominant definitions. First, it can be defined by its (i) pluralism, (ii) anti-essentialism, (iii) anti-foundationalism, and (iv) anti-universalism (Leicester, 2000). This is a direct result of deconstructionism, which rejects modernist metanarratives, instead embracing an interpretive epistemology. It has also been defined as a 'growth of postindustrial and consumer-oriented social formations within an information-rich environment enabled by new technologies' (Harvey, as cited by Edwards & Usher, 2001, p. 275).

Postmodernists endorse a plurality of perspectives, "both in the sense of recognition of the validity of a multiplicity of perspectives or accounts or theories about the 'same' thing, and in the sense of encouraging a way of thinking that is eclectic, drawing on several perspectives, as in the synthesis of elements from more than one cultural tradition, for example. It encourages a blurring or flexibility of boundaries" (Leicester, 2000, p. 74), it adopts an anti-essentialist outlook in the sense that there is no overarching interpretation of words, messages, texts, or concepts – all views are valid – and interpretation is stridently relativistic (Williams, 2003). Postmodernism is characterized as being anti-foundational because it does not hold truth or knowledge as based in a fixed and constant reality. This applies to the internal world of self *and* the external world surrounding the self, wherein context, variation, particularity, and change are important factors in meaning-creation (Leicester, 2000). When these elements are combined, there can be no *grand narratives* that universalize human experience, history, and progress.

Instead, these metanarratives are considered to be created and enforced by dominant power structures (Barr, 2002).

Postmodernists agree that reality is socially constructed, restricted by language, and organized and maintained through narratives (Williams, 2003) that we interpret imperfectly though the limitations of language (Meacham & Buendia, 1999). As postmodernism holds that there is no universal truth, no objective reality, and that language limits epistemological understanding (Meacham & Buendia, 1999; Williams, 2003), learning through a postmodernist perspective consequently becomes a ". . . process of continuous deconstruction of knowledge, of playing with contradictions, and of creatively and productively opening the discourse of a field to an eclectic mosaic of many truths" (Kilgore, 2001, p. 60). This is a sharp departure from modernism which views learning as a linear process, based on the rational analysis of a universal objective reality which can be empirically validated.

Jacques Derrida, a foundational poststructuralist thinker, argued that language creates reality (1976), and through its deconstruction it was possible to identify its internal contradictions, and reveal concealed hierarchies and inconsistencies (Boland, 1995; Williams, 2003). It was then possible to realize the binary oppositions that govern Western philosophy and culture, and interrogate the hierarchies that are predicated on those binaries. Given the power of educational institutions, deconstructing the binaries present in academia is critical to identifying exclusionary hierarchies within higher education that empower certain institutional actors, historically white, Western, heterosexual men, and restrict the agency of others. As Boland notes,

> Research is above teaching, doctoral studies over masters and bachelors over associate degree studies. Private education is over public education, professors over students, administrators over professors, tenured over non-tenured professors. The list is long. To deconstruct these discourses is to indicate first that they are social constructions and did not emerge from some inherent, universalistic rationale or logic. It is to point out the hidden contradictions, inconsistencies, and ambiguities within academia, to show just how much hierarchy is based on what look like arbitrary exclusions, and to illuminate how much they serve to put other ideas and people on the margin or exclude them entirely (Boland, 1995, pp. 527-28).

Postmodernists, therefore, would see education as an act of reinforcing power structures within society, not dismantling them, by categorizing what knowledge is and is not considered valid or valuable through language, and who does or does not have agency in creating that knowledge. Postmodernists would argue that this directly affects the type of pedagogy used within university institutions, restricting student-centered pedagogies that empower learners, in favour of an instruction paradigm that is teacher-centered.

This conception of educational institutions as gatekeepers of knowledge is similarly supported by another key poststructuralist, Michel Foucault. Foucault expands on Derrida's work by examining the value-laden binaries that Derrida identified to analyze their impact on people, politics, and institutions. He focuses particularly on the relationship between knowledge and power, and how the modernist view of knowledge as being emancipating and liberating can also be a method to marginalize anyone who does not conform to the dominant paradigm of what constitutes knowledge within accepted academic and social discourse (Barr, 2002).

The postmodern perspective founded by Derrida and Foucault, touches on all three themes in the thematic framework introduced in *Chapter 1: Introduction*. The theme of agency comes up in the question of who has power and who does not. At the core of that discussion, however, is pedagogy: what is knowledge, how is it established, and how is it communicated? Both Derrida and Foucault are interested in the relationship between pedagogy and agency, seeing conventional pedagogy as a tool to communicate specific discourses that reinforce powerful social hierarchies. As to the theme of change, both Derrida and Foucault are curious how change can take place through deconstructing the social binaries that have established restrictive social hierarchies. Postmodernism, as a theoretical perspective, has therefore had a profound effect on the practice and pedagogy of higher education. The following section discusses that impact in more detail, by defining postmodern pedagogical practices.

2.2.2. Postmodernism and Pedagogy

A postmodern perspective would question university education and the power relations within it, starting with the social positions of student and teacher. These roles are social positions based upon specific discourses that have set up a binary between the teacher as knowledgeable and students as unknowledgeable. These positions are rejected by postmodern theorists, as teachers and students all possess knowledge gained from their subjective experiences. The instructor’s authority is valid insofar as the institution, through its institutional discourse, has established it (Boland, 1995). An example of such instructor authority is displayed through the production of and adherence to a course syllabus. According to postmodernists, such an approach exemplifies submission to normative rules, not necessarily a better form of disseminating knowledge.

However, instructor knowledge is limited; infinitesimal compared with what could be known. This is because knowledge is multi-faceted, and there are always multiple ways of knowing (Edwards & Usher, 2001). For example, a postmodern educator would seek various interpretations of a text and would encourage students to challenge dominant interpretations by viewing the text from different perspectives and multiple readings (Kilgore, 2001). Postmodern educators would also question where meaning authoritatively resides, recognizing that meaning can be found within learners themselves who interpret the texts, rather than an authority that interprets the text and presents that interpretation as the meaning learners should make.

Postmodern learning environments are in a constantly developing state, always evolving and emerging according to the learning context and the learners (Edwards & Usher, 2001; Ostrom et al., 2008). Postmodern educators recognize university learners as potentially holding many social positions other than ‘student’, all of which will impact their learning processes (Ostrom, Martin, & Zacharakis, 2008). Therefore, postmodern approaches to pedagogy aim to mix up the traditional social positions and to diffuse power relations between instructor and student. Kilgore (2004) claims that within university education such binaries may already be blurred due to the experience and knowledge university learners may already have if they are returning to studies, already have a degree, or have spent time in the workforce, etc.

Therefore, postmodern pedagogy embraces difference, understands learning to be a shared experience, and recognizes knowledge and meaning are constantly in flux. University learners in a postmodern context are expected to identify differences between their worldview and that of their peers, thereby recognizing the influence of their cultural, socioeconomic and institutional pathways. However, "making difference central and then constructing a shared learning experience that aims to transcend hegemony while suspended within it is not an easy task" (Kilgore, 2004, p. 51).

The following section defines neoliberalism, and then details its impact on Canadian universities, discussing how university pedagogy is seemingly changing to support neoliberal learning objectives, and in the process curtailing the agency of universities, academics, and students to choose anything else.

2.3. Neoliberalism and the Postmodern University

Neoliberalism is ". . . is variously articulated as advanced liberalism, neo-conservatism, economic liberalism and economic rationalism" (Davies, et al., 2006, p. 306). It is a result of the return to *laissez-faire* economic liberalism of the 19th century following the Second World War, whereby public institutions that were previously supported as essential to societal well-being became reconstituted as part of the market. Many public sectors were early targets of this ideology in the 1980s, being privatised or transformed by neoliberal practices. These practices included increased exposure to competition, increased accountability measures, and the implementation of performance goals in the senior management contracts (Davies, et al., 2006). Coming out of the 1980s and through to today, the same measures were introduced into universities (Davies & Peterson, 2005).

In this new model of the university, economic productivity is not a result of government investment in education, but from commercializing education and repositioning it as a valuable global commodity (McLaren & Farahmandpur, 2005). Education becomes its own market, and university education is reconstituted as a purchasable good (Jarvis, 2014). Thus, higher education becomes a ‘knowledge industry’ which is supported by domestic students, but also “. . . brings fee-paying students into the country, ‘boosting’ the national economy, with education becoming a crucial ‘export good’. . .” (Davies & Peterson, 2005, p. 77). Furthermore, within this commercial model university productivity is no longer measured by its generalised social and economic good, but instead calculated by its definite economic returns and marketable products. When these returns are graduating students, or research activities and publications, neoliberal government policy can be disguised as funding academic work as usual. When the ‘products’ to be funded are research projects that strongly encourage – or outright require – collaboration with industry, there is no disguising the corporatization of academic research. Due to this change in how the university is understood, its agency is curtailed, and its pedagogy is reformulated to serve neoliberal objectives.

Perhaps the best depiction of how neoliberalism has changed universities is articulated by the former President and Director of the National Humanities Center, Dr. Geoffrey Harpham. Although his description of these effects is specific to the American university context, it captures the broader neoliberal reality affecting universities globally:

> The markers of corporatization are so numerous that enumerating them makes one feel that there is nothing left to enumerate: the proliferation of

administrative positions, the huge gulf between faculty and top administrative salaries (not to mention the gap between the highest paid professors and assistant coaches), "performance" bonuses for deans, "incentives" for faculty performance, persistent attacks on tenure, the rise of profitable "distance learning," the transformation of academic units into cost centers subject to quality assurance guidelines, conflicts between academic freedom and corporate interests, expansive claims by the university of faculty members' intellectual property rights, the inexorable growth in the number of adjunct faculty, the "outsourcing" of services, … the veneration of "entrepreneurship" in all areas of the university including undergraduate programs, the diminishment or cooptation of faculty governance, decreased administrative and trustee transparency, the humbling of academic disciplines before paradigms of assessment grossly inappropriate to them, decisions to shutter "unproductive" departments (classics, German, philosophy), institutional mission statements couched entirely in management rhetoric, the tendency to treat students as customers who must always be right, the tendency on the part of faculty to compete for students by offering attractive electives (and a counter-tendency to devote most of their attention to the professionally competitive activity of research), the recession-proof growth of athletics…, an eagerness to brand and even to franchise the institution—and, in recent years especially, the thundering appearance of very large for-profit universities whose unembarrassed mission statements address (if they do not always meet) exclusively vocational goals. (Harpham, 2011, p. 48)

As Harpham makes clear, “the postmodern university no longer aims to transmit truth or a tradition but rather produces professionals and technicians to service the new knowledge economy.” (Walters & Kop, 2009, p. 28). As the university becomes subject to and operates through a neoliberal paradigm, the alternative conception of education that postmodernism offers is jeopardized. The purpose of education becomes the creation of a flexible set of skills which can be reused and recycled across varied contexts. The term ‘knowledge management’ replaces talk of an individual developing his/her abilities or knowledge and the quest for truth; knowledge becomes a commodity to be produced and sold in the market place, and “education has no value unless information can be converted into money” (Sarkan & Nemec, 2010, p. 108). This redirection of university pedagogy towards market objectives strips university education of its critical and emancipatory functions, and the value of educating a critically aware and engaged citizenry is further called into question, threatened by neoliberalist views that knowledge is only valuable if it is potentially profitability.

Instead of rejecting this notion of higher education, Canadian universities have essentially responded to this neoliberal framework by embracing it. Of course, there are pockets of resistance among students and faculty, but the overarching approach taken by senior administrators has been compliance (Turk, 2014). Which is not surprising, given the difficulty of resisting such a strong effort on the part of the federal and provincial Canadian governments to push the nation’s universities to be profitable by reducing public funding of higher education (CAUT, 2013; CAUT, 2015b), and interfering in their institutional autonomy (Delanty, 2002) – a continuing trend in Western higher education in general (Davies, et al., 2006,; Jarvis, 2014).

Canadian universities have responded in line with other Western universities by relying on precarious workers, or contractual staff, which are also known as adjunct professors, per-course instructors, or sessional staff, to help them offset the cost of educating students (Charbonneau, 2014). They have tried to raise revenue by aggressively pursuing international student enrolment to take advantage of the higher tuition fees that they charge international students, without effectively supporting them (Humphries, Knight-Grofe, & Klabunde, 2009). Additionally, they have directed research towards industry concerns and commercial gain (Franklin, 2000; Graham, 2000) – a response to a reduction in public funding for research and the government redirection of public research funding towards commercially viable research projects (CAUT, 2013). All of this impacts the integrity of university education, further aligning university pedagogy with neoliberal learning outcomes, and restricting the agency of universities and academics to operate outside a neoliberal institutional model.

The following sections on the *Contemporary Canadian University*, break down the effects of neoliberalism on the university by detailing the rapidly decreasing autonomy Canadian universities have to establish their institutional activities, the funnelling of federal and provincial university research funds towards industry partnerships and priorities, as well as the increased reliance on contractual teaching staff and internationalization as funding strategies for dealing with declining public funds.

2.3.1. Contemporary Canadian Universities: A Loss of Autonomy[13]

As higher education becomes increasingly promoted by the Canadian government as an important domestic and international industry, the more governments are dictating where funds should go. Universities are losing their autonomy, and in doing so, their capacity to be responsive to their environment. A current example of this is the intervention of the provincial government in Albertan higher education. When the Government of Alberta released its 2013 Budget, it set out $2 billion in base operating grants for post-secondary institutions, which was a $147-million decrease from 2012-13 (Government of Alberta, 2013). The 6.8% cut in operating grants is a sharp reversal of what was expected however, as the 2012 budget promised institutions predictable 2% increases to their operating grants for 3 years to allow them to plan ahead. At the same time, the provincial government also put a tuition freeze into effect, making it impossible for universities to raise tuition to make up for the unanticipated cuts. Enterprise and Advanced Education Minister Thomas Lukaszuk responded to concerns raised about the funding cuts and tuition freeze by colleges and universities – as well as the public – by suggesting post-secondary institutions resolve redundancy issues in their own institutions and across institutions (Weismiller, 2013), a statement echoed by Finance Minister at the time, Doug Horner (Bradshaw, 2013).

Conversely, the Government of Alberta has committed $160 million to the 'Alberta Innovates' program, that looks to fund research that is directly related to and under the purview of the provincial government. This program budget is likely to be partly applied

[13] The discussion in this section reflects the political reality in Canadian provinces referenced at the time of writing. Political climates are continually changing, and what is reported here is true at the time of writing, but may very well have changed since.

to a new initiative being developed by the government, being its plan to open a highly-selective government directed research institution. However, the exact source of funding is yet to be communicated to the public. These developments, combined with the unanticipated and severe funding cuts, have led many stakeholders within higher education to question the government agenda and see it as directly intervening in the independence and integrity of higher education institutions by forcing them to close academic programs that are not considered to have economic value (Wingrove, 2013).

Colleges and universities in Alberta are not alone, as other provincial governments have also begun infringing on the autonomy of their public universities. For example, in Manitoba, the former Council on Post-Secondary Education (COPSE) acted as an intermediary agency between the provincial government and its seven universities and colleges, and was theoretically supposed to protect their institutional autonomy. In reality, however, it did not. COPSE was founded in 1997, and had an 11-member body appointed by the provincial government; the first indication that its mandate conflicted with its membership. The Manitoba government also enacted a serious of legislative changes that further dissolved university autonomy, such as regulating which institutions could offer degrees, determining inter-institutional credit transfer agreements, collecting personal information about university and college students, setting tuition rates and deciding the cost of fees related to education other than tuition, and having sole authority relating to the recruitment, enrolment and progress of international students (Smith, 2014).

Introducing this series of legislative changes has allowed the Manitoban government to control activity related to staffing, academic policy, and admissions, which were three areas specifically singled out as important limitations to government control when COPSE was first convened (Smith, 2014). Seemingly, these legislative changes made COPSE redundant, and it was dissolved in 2014 and replaced with a new advisory committee under the direct control of the Manitoban Department of Education and Advanced Learning (Enns, 2014). The Minister of Education and Advanced Learning said of the change, "…the department now directly oversees the allocation of funding to colleges and universities, ensuring that funding is directed to programs and services that meet the needs of students." (Hatherly, 2015). This legislates significant power over the province's universities and colleges, while directly curtailing their autonomy, but also demonstrates the government's mistaken conceptualization of universities as mere service providers, not complex institutions with important civic roles and responsibilities.

In Ontario, the provincial government released a discussion paper "Strengthening Ontario's Centres of Creativity, Innovation and Knowledge" in 2012, which proposed a set of sweeping changes that included three-year degrees directly responding to the needs of the labour market, making introductory core courses fully transferable across all institutions, as well as expanding online course delivery to account for one-third all courses. When first introduced, there was substantial opposition to this turn towards commercialization and curtailing of university autonomy (CAUT, 2012b; Naylor, 2012). As the discussion paper passed through its various legislative incarnations, it continued to cause concern because it seemed to push post-secondary institutions to specialize in their areas of strength as a cost-cutting measure (Bradshaw, 2013).

A final version of the initial ideas suggested in the 2012 report was published in 2013. Known as the "Ontario's Differentiation Policy Framework for Postsecondary Education" it aimed to divide universities according to their research classification: research universities, research intensive, teaching universities, and special purpose universities such as those that focus on art and design, or information technology. This differentiation based on level of research activity is something that already exists in the Albertan and British Columbian higher education (Bradshaw, 2013). The concern with introducing it into the Ontario university system is that it has essentially curtailed the ability for universities to be self-determined as they have been asked to outline a strategic mandate for their respective institutions that must then be approved by the province which provides their funding (Ministry of Training, Colleges and Universities, 2013; Rappolt, 2013).

This strategic mandate must respond to a very detailed evaluation metric that assesses institutions based on their (i) graduate employment rates, employer satisfaction with recent graduates, and research commercialization; (ii) student engagement and satisfaction, retention rates, graduate rates, and co-op programs; (iii) the enrolment of international students, Indigenous and first generation students, plus students with disabilities; (iv) institutional research capacity, focus, impact, and international competitiveness; (v) enrolment by major and credential in institutional programs, and finally, (vi) institutional collaboration in supporting student mobility between institutions (Ministry of Training, Colleges and Universities, 2013, pp. 13-16). This evaluative scheme is clearly wide-reaching, touching on almost every aspect of university activity, and therefore, has largely been seen by institutions and faculty to be an unwelcome intrusion on university autonomy (Naylor, 2012; OCUFA, 2010; Rappolt, 2013).

The political situation in Ontario, although fraught, does not feature the same open animosity that has been seen in Alberta, and how funding will be determined under the new differentiation framework is still being reviewed following the conclusion of the 2015 University Funding Formula Consultation that consulted with university leaders, student organizations, faculty and employers (Ontario Ministry of Training, Colleges and Universities, 2016). This final report suggests that an outcomes-based funding model for universities should be adopted, and that it would account for (i) teaching and research activity by faculty, (ii) students' success and learning, (iii) financial information and productivity (Ministry of Training, 2015, pp. 56-57). These would augment the evaluation metrics outlines in the 2013 Differentiation Policy Framework, but as the Ontario Confederation of University Faculty Associations (OCUFA) said after its release in 2013, "We are also concerned that the movement towards an outcomes-based funding model will harm students studying at institutions deemed by government to be 'under-performing'. We are also worried that an outcomes-based model will politicize university funding, aligning it to the short-term priorities of the government of the day, rather than the long-term needs of Ontario." (OCUFA, 2013).

Arguably, amidst all these changes, Ontario universities still benefit from having an independent advisory body that is responsible for providing recommendations for post-secondary institutions through rigorous research and policy development: The Higher Education Quality Council of Ontario (HEQCO). Although how much of its research and policy development is truly independent is questionable considering its early endorsement of the government mandated differentiation policy and strategic mandate compliance universities are expected to adopt (Weingarten & Deller, 2010), and its continued research output in support of government objectives. This concern was noted as early as 2010, when OCUFA commented in response to the report the HEQCO released supporting differentiation, that its “paper continues a disturbing trend in HEQCO’s research: starting with a conclusion – usually based around a political goal, like saving the government money – and then conducting research that tends to support that conclusion. HEQCO should be conducting research aimed at producing good policies that address real issues in the university sector, not aligning itself with fiscal restraint narratives emerging from the provincial government.” (OCUFA, 2010).

In Nova Scotia, the situation is openly hostile. A bill was passed by the provincial legislature that bans strike action and suspends collective bargaining agreements for up to 18 months in situations where universities have a significant operating deficit and seek government financial support (Nova Scotia Legislature, 2015). Given the provincial population demographics, there is already a significant lack of student enrolment, with only 43,905 students in the university system (Statistics Canada, n.d.). This is only expected to continue as the population ages and the number of people between the ages of 18 – 29 is expected to fall by a quarter in 15 years (Choise, 2015). Accessing funding would require administrations to enter a ‘revitalization planning process’ that would disallow union action during the process. It would also provide total control of the strategic direction and operations of the university to the three to eight members appointed by the Minister of Labour and Advanced Education to a revitalization-plan advisory committee. Any dissenting university, union, or faculty action during the process would be punished by substantial fines. Bill 100 went into effect on May 11, 2015. It has received significant criticism from faculty and union associations (CAUT, 2015c; Laroche, 2015; NSFL, 2015; Withers, 2015).

In Newfoundland, the relationship between the government and the sole provincial university has historically been much more collaborative. Memorial University (MUN) has enjoyed a supportive relationship with the province up until now, but must now respond to significant cuts to its base operating expenses due to a budgetary crisis affecting all aspects of public funding (Government of Newfoundland & Labrador, 2016a). MUN must contend with an $8.3 million dollar cut in its operational budget, after having their budget cut by $20 million the year prior (CBC News, 2015) and $3 million less for employee salaries (Boone, 2016). Additionally, there will be significant cuts to its Faculty of Medicine operational grant and reduced financial support various other aspects of the faculty's activities by a further $2.5million (Government of Newfoundland & Labrador, 2016a). These direct cuts do not account for other issues affecting higher education introduced by the budget – such as taxing the sale of books, eliminating scholarship programs for students, reducing funding for youth and student services, eliminating grants in lieu of student loans, eliminating the government job website, and reducing funding to various provincial organizations that often hire students (Government of Newfoundland & Labrador, 2016b). All of this will have an impact on Memorial's ability to recruit, retain, and educate its students.

The budget cuts will also significantly affect the choices young people in the province – of which there are fewer and fewer – make in terms of if and where they decide to pursue university study (Gillis, 2016). Although there has been a tuition freeze in effect for the last decade, the government did not mandate that MUN continue the freeze, with the Minister of Finance unequivocally stating it was not a government decision, “MUN is accountable, and has the autonomy, and has always had the autonomy to do things they need to do…We expect that because we're providing them with continuation of the tuition money.... they will make their decisions in the best interest of the students." (Barry, 2016). While this is a positive statement in support of university autonomy, it does mean MUN will have to make difficult decisions about how it will cover the costs of the budget cuts. Before the cuts were introduced it had already been aggressively pursuing the recruitment of international students, and had raised international and graduate student tuition fees (Howells, 2015), so that revenue angle is already being exploited, even if further fee increases are on the horizon. Therefore, it must do what all universities now do – pursue external funding and commercialize university research – which has progressively become an important source of institutional revenue (CAUT, 2013).

The themes of agency and change are both important to this discussion. As universities are changed by the neoliberal expectations placed on them by government, industry, and society, they are also losing their agency. This curtailed autonomy and how it affects one of their key functions, research, is discussed in the following section.

2.3.2. Contemporary Canadian Universities: The Commercial Campus

Universities are turning toward industry and commercial pursuits to make up losses from the public purse, which further curtails their autonomy. Industry partnerships, and in general a commercialization of university education and research, has become a common – even core – activity of contemporary universities (Turk, 2000). This is not surprising as federal grants for research have dwindled, with all three major funding agencies experiencing decreases. Between 2007-08 and 2013-14, funding for the Social Sciences and Humanities Research Council (SSHRC) has fallen by 10.1 per cent, the National Science and Engineering Research Council (NSERC) funding is down 6.4 per cent, and the Canadian Institute for Health Research (CIHR) funding has declined by 7.5 per cent (CAUT, 2013, p. 2). These decreases include a 9.6% reduction in NSERC funding for basic research during the same time frame, and 9% less funding for investigator-framed research (CAUT, 2013, p. 3). This change in government agenda did not suddenly happen, however, as Canadian academics were raising their concerns over "…university support of technological change and private sector development as the dominant, guiding vision of future higher education policy." as early as the 1970s (Buchbinder & Newson, 1990, p. 359).

As basic research funding has dwindled, funding for applied research has increased – because funds are shifting away from basic research. 'Target research' is university research carried out with an industry partner or in relation to commercial goals (i.e. advancing intellectual property that can be immediately commercialized) and receives preferential funding. This push towards research commercialization is arguably counter effective in reaching the federal government's intended aims, as "The history of scientific progress reveals that the most fundamental advances in knowledge that lead to new products and applications have their origins in basic scientific research with no predicted commercial outcomes." (CAUT, 2013, p. 5). Distinguished Canadian physicist, Ursula Franklin captures the effects of these changes to public funding in Canada:

> Our long and hard fight for public investment into higher education has yielded industrial scale production sites that are essentially assembly plants for economically useful knowledge and training facilities for skilled practitioners. They are profitable plants, but not universities or colleges…These plants are not places to transmit to the young, values, knowledge, insights, skills and critical abilities to cope with the future – unless one believes that the global future is solely profitable commerce and business as usual. (Franklin, 2000, p. 20).

Unfortunately, there is limited vision beyond a global future that is not dominated by commerce, which has already been demonstrated through the preceding discussion of provincial and federal government policies, actions, and expectations regarding Canadian universities. Franklin talks about this vision as '…a general, technologically facilitated shift of power and accountability" (Franklin, 2000, p. 21), and notes that this shift is felt not only in universities, but other public institutions that are subject to neoliberal ideologies that view the world purely through an economic lens. Essentially, the contemporary university exists within an all-encompassing neoliberal paradigm, wherein university education and research are conceived as commercial goods, and their respective purposes and directions are driven by market forces (Guruz, 2011).

Consequently, universities are becoming increasingly corporatized. Academic research is expected to produce commercial activities; university learning is expected to produce a workforce with an entrepreneurial attitude, capacity to learn, intercultural skills, and the skills that are necessary to adapt to the new ways of using knowledge and organizing work to produce goods and services internationally. Universities are expected to change the way they are organized so that they can produce profit and effectively compete for students, scholars, and resources in the global higher education market (Guruz, 2011). This shift is seen in the attitudes of presidents appointed by university boards (Keller, 2009; Turk, 2014), the agendas universities set or have set for them by external stakeholders (CAUT, 2013; Stevenson, 2004), and the partnerships that universities enter into with industry heavyweights (Graham, 2000; Turk, 2010). This is one of other strategic positions that universities might adopt in adherence to, or response to, this neoliberal agenda.

Professor of Education, and former Vice-Chancellor of Keele University, Nicholas Foskett, specializes in education policy and management, and realizes that many universities feel compelled to take an *economic position* in which they regard themselves as a knowledge business battling for market share. He argues, however, there is a *cultural position* they can take, in which universities act as key cultural mediators in the encounter between world culture and national cultures. They might also adopt a *stewardship* *position* in which they fulfil guardian roles alerting societies to major emerging issues (Foskett, 2010, p. 38).

Despite the importance of the two latter strategic positions, there is a constant pressure on universities to adopt an economic position, in which knowledge is valued for its economic potential (Delanty, 2002). “This instrumentalization of knowledge has meant that the kind of knowledge that is particularly prized in a knowledge economy is that which may be readily transformed into marketable products and services. This re-situating of knowledge as a tradable product radically changes the role of university research . . . such that knowledge is increasingly being produced for, and in the context of, application.” (Gibbs, 2010, p. 243). Faced with increased competition, universities are therefore tempted to invest in subjects that are going to be most profitable for them, to the detriment of less profitable ones such as social sciences and humanities. Furthermore, they will also be drawn to doing research that pleases their funding sources (Gibbs, 2010).

The theme of agency is again relevant here, as is change. Universities are coping with changes to their funding structure and research activities, and a big component of that change is the loss of agency they have in determining their own research priorities. This discussion of change and agency also features in the following section about the other key function of the university: teaching.

2.3.3. Contemporary Canadian Universities: Undervaluing University Teachers

As universities cope with significant reductions in government sponsored university research funding and the redirection of federal monies towards marketable research, they are also losing public funding of their basic operating expenses and adopting market-based strategies to deal with that loss. They are increasing student enrolment to increase tuition revenue, and are relying on short-term, contractual staff to teach undergraduate courses. Investments in tenure-track faculty who command much higher salaries and expensive employee benefits continue to dwindle, and contractual teaching staff numbers continue to swell.[14]

Although there is a positive aspect to increased student enrolment, as it welcomes more students into universities that have been traditional excluded, the motivation for upping student enrolment is financially motivated. To cover their operating expenses, universities must take in more students. Tuition now constitutes 38% percent of nationwide Canadian university operating budgets and is a crucial component of their revenue stream (CAUT, 2015a). While tuition revenues have increased, there has been a simultaneous cut in expenditures on academic salaries (CAUT, 2015b). According to the most recent statistics, spending on academic salaries as a proportion of total university expenditures has declined from 30% in 1981 to 20% in 2012. At the same time, however, university budgets have swelled, with total university expenditures increasing by 205% between 1982 through to 2012 (CAUT, 2015b, p. 1).

One contributing factor to these increased expenditures are the salaries and associated benefits and retirement packages awarded to senior university administrators (Government of Ontario, 2014; Serebrin, 2011), as well as the trend towards expanding university administrative staff in general (CAUT, 2015a, p. 7). As of 2013, 6 out of 10

[14] Although many Canadian universities do not publish contractual staff statistics, the consistently low levels of new tenure-track positions and growing student enrolment figures collected annually, supports the available statistics and research showing contractual teaching staff now perform much university teaching.

dollars spent on wages and benefits in Canadian universities were spent on non-academic staff, when only a decade ago they accounted for less than half of all salary and benefit costs (CAUT, 2015b, p. 13). Considering the incredible increase in student enrolment over the last ten years, spending more on administrators instead of teachers seems paradoxical, as an increased student-faculty ratio affects the quality of university education (Allais, 2014; Hornsby & Osman, 2014), Furthermore, the high compensation of senior administrators is a fact that consistently makes headlines, and does not sit easy with the public (Basen, 2014; Fredrickson, 2015; Taylor-Vaisey, 2008).

These realities are especially disconcerting as it is generally thought that sessional instructors are increasingly responsible for one of the most vital university functions – teaching students – but unlike administrators and tenured faculty, they earn low wages, with minimal to no benefits, and have little to no job security (Findlay, 2011). They are also often hired to teach crucial foundational courses in first and second year degree programs (Fredrickson, 2015; Yakoboski & Foster, 2014), which are typically large classes, with many students new to university study, which places additional expectations on sessional instructors hired to teach these courses to work above and beyond their contractual obligations (Basen, 2014; Charbonneau, 2014). CAUT estimates that 40 to 60 per cent of undergraduate teaching is now done by sessional instructors (CAUT, 2015b); with a recent report from the Higher Education Quality Council of Ontario confirming this increasing reliance on sessional staff (Field, et al., 2014).

Unfortunately, exact statistics on sessional numbers and employment conditions are not known because most universities do not disclose this data (Charbonneau, 2014; Field, et al., 2014). Recent media investigations have discovered, however, that Assistant, Associate, or Full Professors earn a salary anywhere from $80, 000 - $150, 000 per annum for teaching a full course load of 4 courses a year, but a sessional instructor will earn $28, 000 for teaching the exact same four courses (Basen, 2014). Although hiring sessional instructors is one method universities have adopted to address the greater student to teacher ratio, this is a solution that the general public increasingly questions, especially as universities continue to pretend the majority of teaching is being done by prestigious researchers who are experts in their field and paid well (Findlay, 2011; Fredrickson, 2015).

Despite this significant change in education provision, within Canada there “has been little research on part-time faculty or how changes in the academic workforce are impacting the quality of the student experience, the balance of teaching and research activities within the institution, or the culture of academic units” (Field, et al., 2014, p. 11). Data from the United States, however, suggests that when adjunct faculty enjoy hospitable working conditions, students benefit from their instruction, but students do not benefit from learning from adjunct faculty who experience poor working conditions (Erwin & Wood, 2014; House Committee on Education and the Workforce, 2014). Unfortunately, most Canadian universities continue to exploit sessional instructors as a solution to soaring enrolment numbers (Charbonneau, 2014).

2.3.4. Contemporary Canadian Universities: Internationalization

Clearly, the pressure placed on universities to generate revenue to support their operations often leads universities to make choices that can negatively impact students. In addition to relying evermore on sessional instructors to reduce their operating costs, universities are also generating revenue by increasing the number of international students, who pay substantially higher tuition fees than their domestic peers. Total international student numbers as of 2010 were: 49,641 fulltime students, 16, 074 master's students, and 11,169 doctoral students (Statistics Canada, n.d.), making up 10% of total university student enrolment in Canada. As of 2014, the rise in international student enrolment has increased again, with 67, 839 fulltime international undergraduates, 22,245 fulltime master's students, and 15, 075 doctoral students (Statistics Canada, n.d.), making up 13% of total university student enrolment in Canada.

Unfortunately, universities have not been as vigorous in providing support for international students, as they have been at recruiting them (Anderson, 2015). Not only do international students face difficulties off-campus when navigating government bureaucracy, finding employment, and financing their studies and living expenses (Humphries, Knight-Grofe, & Klabunde, 2009), they face challenges once on-campus. Programs offered by universities to promote cross-cultural contact and communication between international and domestic students and faculty have shown limited and usually temporary impact at best on the social norms of domestic students and faculty (Edmead, 2013; Tian & Lowe, 2013). Negative perceptions of international students still exist, and the mere presence of international students on campus does not automatically create an inclusive environment (Shannon-Little, 2012). Changing assumptions and stereotypes that domestic students, staff, and faculty may hold requires ". . . risk-taking, acts of faith, dissent and teachers who are reliable guides. All this does not sit well with the commodification of the learning relationship" (Caruana, 2010, p. 55).

That commodification of university learning, however, is seen to be an effective funding strategy by the Canadian government, and increasing international student enrolment is being strongly pushed by the federal government (Foreign Affairs, Trade, and Development Canada, 2014; Advisory Panel on Canada's International Education Strategy, 2012). Increasing international student enrolment is seen to be a solution to various economic woes – not only an approach for funding its public universities, but also integral to addressing various national and regional economic problems. Despite literature advising against this transactional perspective on international students (Maringe & Foskett, 2010), the federal government remains focused on increasing international student enrolment because of the economic benefits they bring to Canada, which are characterized by McMullen & Elias (2011) as:

- Supporting Canada’s science and technology and innovation agendas through international partnerships and exchange of talent
- Capitalizing on alumni networks established through international students to develop foreign partners important to Canada’s national and regional economies
- Addressing demographic and labour market issues by aligning international student immigration and labour market strategies
- Building on the immediate benefits of international education for Canada, that include economic growth, job creation, and increased exports and investment

These immediate benefits are indeed quite great. In 2012, a report commissioned by Foreign Affairs and International Trade Canada indicated that in 2010, international students in Canada spent approximately $7.7 billion on tuition, accommodation and discretionary spending. This number was up from $6.5 billion in 2008, seeing over a billion dollars in growth within a short-term timeframe. The report also accounted for additional tourism benefits occasioned by international students, to find that the total expenditure resulting from international students in 2010 to be $8.0 billion (Advisory Panel on Canada's International Education Strategy, 2012). In effect, this meant that in 2010, international student expenditures were responsible for creating 86,570 jobs and contributing $455 million in government tax revenue (Roslyn Kunin & Associates, Inc., 2012). Given the high value of international students to the Canadian economy – both in the short and long term - the federal government wants to double the number of full-time international students, from 239,131 in 2011 to more than 450,000 by 2022 (Roslyn Kunin & Associates, Inc., 2012, pp. 35-37).

However, instituting a model of practice in higher education that relies on international student tuition to address budgetary shortfalls is problematic (Matthews, 2012). Universities outside North America and Europe are continuing to improve the quality of their education – often in partnership with Euro-American institutions – and students may begin choosing to go to universities in their home countries instead of pursuing the costly, stressful, and often – discriminatory and bureaucratically demanding – path of studying and possibly working abroad post-graduation (Fisher, 2013; Matthews, 2013; Vaidyanathan, 2013). This is particularly true of countries like China, which accounted for 30% of fulltime and part-time international students in Canadian universities in 2012 (AUCC, 2014, p. 24), whose institutions are becoming competitive with Euro-American universities as demonstrated by the Times Higher Education World University Rankings (THE, 2016) and may lead to more students opting to forgo the multitudes of stresses associated with studying overseas in favour of being educated at home.

2.3.5. Contemporary Canadian Universities: Concluding Thoughts

The loss of agency Canadian universities are experiencing, the redirection of university research towards industry objectives, as well as the reliance of contractual teaching staff and international student fees, are negative results of the neoliberal practices being adopted by, or in some cases, forced upon, universities. Understandably, there are pressing concerns about the role of universities and the coopting of their practices. However, there are also basic realities that are in play and cannot be wished away, finding ways to support teaching and learning within universities within a changing system is needed. It is therefore important to find strategies that operate within this commercial structure while retaining the integrity of university education.

The following sections are concerned with finding these strategies, and define change as theorized in change management literature, then examines how change takes place within universities. Universities are not typical organizations, as their command structure is complex. Therefore, the theme of agency is also explored in the following examination of institutional change within university organizations.

2.4. Change and the Postmodern University

Neoliberalism, and the challenges it presents within the Canadian university system requires a response that is critical, interpretive, and situated outside this dominant paradigm. Without such a response, the emancipatory function of universities and their social roles as arbiters of culture and social mores is in jeopardy (Giroux & Cohen, 2014; Turk, 2000). These functions are even more important as society continues to be dramatically changed by rapidly advancing technologies that disrupt established social and cultural beliefs, practices, and customs (Franklin, 2000).

Luckily, despite the recent curtailing of university autonomy from external forces, there still exist intricate power dynamics between faculty and administrators that can either facilitate, resist, or reshape institutional change. On one hand, this is an advantageous institutional feature. Despite increasing demands on universities by government, industry, and some senior university administrators, to adopt neoliberal practices by participating in the knowledge economy and realizing its objectives of commercializing knowledge, producing employable graduates, and capitalizing on student enrolment, resistance is still possible. On the other hand, these same organizational structures make change difficult.

Canadian universities are complex organizations. What is crucial about the structure of a university hierarchical system as opposed to a traditional corporate hierarchy is the relative independence and dominion that faculty and lower level administrators (such as Deans and Department Heads) have over their own areas of formal authority (Metcalfe, et al., 2011). This is because there are a multitude of smaller hierarchies within the larger university organizational structure (and subsequent hierarchical system) and each of them may directly control a valued resource, giving them power over other persons who would otherwise have formal authority over them within the broader university hierarchy.

Furthermore, the academic hierarchy has been deliberately structured to preserve the autonomy and independence of its members through the designation of academic tenure to facilitate the best-functioning of academic work by guaranteeing their academic freedom to pursue research of their choosing – even that which might otherwise threaten their employment status or actively challenge external stakeholders (Metcalfe, et al., 2011). Even in Nova Scotia, where faculty unions have been disenfranchised, tenure is protected (Nova Scotia Legislature, 2015). Thus, even tenured faculty are afforded autonomous power within the overlapping hierarchies that constitute the organizational structure of the university, confusing the issue of who holds power where and in what context. Essentially, the configuration of the university is predicated on "non-linear decision-making, preference for ambiguous actors, paradoxes and [a] double bind in management," (Rebora & Turri, 2010, p. 286), which entrenches the current structure even though it can be inefficient and even obstructive.

Strydom, Zulu, & Murray (2004) identify a variety of individual and organizational barriers to change that are specific to the university contexts. First, they speak to individual characteristics such as habit, security, economic factors, fear of the unknown, selective information processing, and myopia that can create resistance to change. In terms of *habit*, people deal with complex environments through programmed responses, and "habits are rooted in people's cognitions (beliefs and attitudes) about change. . .and the plethora of policy driven changes can lead to 'change fatigue' and academics who continue with ‘business as usual’ or traditional methods despite external demands for improvement of practices.” (Strydom, Zulu, & Murray, 2004, p. 212).

Change is also resisted in terms of *security* because it threatens people’s sense of security to shift their behaviors, habits, and introduces the possibility of losing their livelihood. As Brown (2012) notes “the concept of academic identity needs to be taken into account when making changes in higher education. A great deal of effort needs to be put into understanding the current status and previous history of the organisation and allocating resources (people as well as money) to make such changes meaningful, taking full account of institutional cultures and contexts.” (p. 41). Therefore, changes within universities that threaten the job security of its personnel are resisted, especially as changes engender a *fear of the unknown.*

In terms of organizational barriers to change, Strydom, Zulu, & Murray (2004) identify the following: structural inertia, limited focus on change, group inertia, and threats to expertise, power relations and established resource allocations. Of these barriers, it is structural and group inertia, as well as threats to expertise, that are most relevant to this case study. *Structural inertia* concerns mechanisms built into the institution that create stability, such as explicit procedures that are formalized within the institution (ex. qualifying for academic tenure) to those that are implicit within underlying institutional assumptions and cultural practices (ex. valuing research activities over teaching). Universities are characterized by this type of inertia, as faculty focus inward on their research and remain isolated in disciplinary silos (Henkel & Vabo, 2006). This is then reinforced by *group inertia*, which develops when specific group norms solidify resistance to change, and can include leadership inaction, collective action problems, and cynicism (Strydom, et al., 2004). Sometimes, this inertia is a simple effect of organizational life, which protects a collective identity (Anderson, 2011).

Salient to this study, however, is how *threats to expertise, power relations and established resources* play out in the hierarchy of the university and its particular power dynamics. As Strydom, Zulu, & Murray (2004) note, "Changes in organizations threaten the expertise of specialized groups and challenges existing power relations and established resource allocation to specific parts of the organization." (p. 213) meaning there will be that much more resistance to change within universities because expertise, specialization, and resource allocation are already fraught subjects within the academy. Resistance, however, is not necessarily damaging to a change process, as it is part of organizational life and a natural response to change, which should be considered valuable feedback (Bovey & Hede, 2001; Ford & Ford, 2009). Therefore, the focus should be on developing a leadership approach that can overcome resistance to change, by incentivizing others instead of threatening their sense of control and autonomy (Geller, 2002). However, leading change has largely been viewed as a one-dimensional process, focused on a specific type of change leader (Caldwell, 2003), and a top-down, planned approach to change (Cameron & Green, 2012), that does not meaningful engage with the culture of an organization – which can impede or torpedo a change effort (Cameron & Quinn, 2006).

When reviewing the management literature on how change has been initiated within organizations, Caldwell (2003, p. 140) realized there were four different models of change agency, each viewing the ‘change agent’ through a different lens, and offering different possibilities for how change can be led:

1. **Leadership models:** Change agents are identified as leaders or senior executives at the very top of the organization who envision, initiate or sponsor strategic change of a far-reaching or transformational nature.
2. **Management models:** Change agents are conceived as middle level managers and functional specialists who adapt, carry forward or build support for strategic change within business units or key functions.
3. **Consultancy models:** Change agents are conceived as external or internal consultants who operate at a strategic, operational, task or process level within an organization, providing advice, expertise, project management, program coordination, or process skills in facilitating change.
4. **Team models:** Change agents are conceived as external or internal consultants who operate at a strategic, operational, task or process level within an organization, and may include managers, functional specialist and employees at all levels, as well as internal and external consultants.

Caldwell (2003) provides an important overview of how change agents are conceptualized and utilized in organizations, however, current research shows it is a *team model* of change that is most effective because change that is participatory, led with involvement from a broad range of stakeholders, and engages in constant dialogue between persons leading change and those they are leading, is more effective than a top-down approach to change (Katz, 2013; McGinnis, 2013). Therefore, change champions can be “people at any level of the organization who are skilled at initiating, facilitating, and implementing change” (Warrick, 2013, p. 517). Although this seems tautological, the key point being made is change must be led *at all levels of the organization*, and the skills needed are described as a collaborative process.

Furthermore, the research shows that planned change is not as effective as allowing change to happen organically, although “…some elements of the process must be readily available, clearly articulated, designed to motivate people and foster loyalty and to serve as an underlying strategic foundation…” (Anderson, 2011). Quinn (1996) describes this as moving through the ‘transformative cycle’, which is a fluid process of *initiating* a change, *experimenting* with a change despite uncertainty, *transforming* old paradigms, and *routinizing* new paradigms.

In summary, the structure of the university is predicated on hierarchy and stability, and because the relationships between its institutional actors are complex it is slow moving (Brown, 2014). Therefore, the way to create change within the university is through a participatory process, which is not minutely planned and prescriptive, and led by change champions operating at various levels of the hierarchy (Anderson, 2011). Accounting for diverse individual perspectives and engaging resistance to any proposed change(s), helps facilitate a ground-up approach to change, and permanently alters organizational cultures that may limit change (Cameron & Green, 2012). Constructing an effective change strategy within the university thus requires an understanding of the persons within the institution and their relationships to one another, as well as: (i) a focus on the interdependence of and interactions between individuals and groups at multiple organizational levels; (ii) an awareness of the effects of internal and external organizational factors impacting the change initiative; (iii) an appreciation of the ongoing effects of the past on the present and future; (iv) the importance of the ideas that mediate between organizational conditions and actions; and, (v) an openness to the effects of change, especially the emergence of new systems and activities (Scott, 2010, pp. 17-18).

This characterization of change – bottom-up, focused at the individual, not the organizational level, and rooted in past and present discourses – aligns with a change process discussed in education theory, that of critical pedagogy. Although change management theory and education theory stem from different epistemological traditions and have different objectives, there are similarities between each body of knowledge when looking at the concept of change broadly: they are both concerned with the individuals involved in, impacted by, and responding to a change process. Where they differ, however, is in their motivation for introducing change. The founding goal of critical pedagogy is to create social change by guiding oppressed persons through an education process that enables them to experience personal change by changing their understanding of their world and the structures in it that oppress them. The ultimate goal of critical pedagogy is a collective change in group behaviour whereby oppressed persons no longer accept oppressive social structures because they become aware of them and are changed by that knowledge (Freire, 1970). The following section discusses this in detail.

2.5. Pedagogy for Change

Despite challenges to university learning in the postmodern era, there is still a possibility and a desire for transformative education. Transformative learning is a deep shift in perspective, which happens through critical reflection, propelled by an individual or group of persons who encounter a perspective that challenges their preferred discourse (Cranton, 2011). According to Mezirow, whose 1975 study of American women resuming education after an extended leave of absence from post-secondary studies or the workforce became the basis of his theory of transformative learning, an initial disorienting dilemma triggers the individual to engage in a reflective practice. Individuals examine their existing frames of reference, and then act on that reflective insight after critically assessing it to "help the individual become a more autonomous thinker by learning to negotiate his or her own values, meanings, and purposes rather than to uncritically act on those of others" (Mezirow, 1997, p. 11).

Transformative learning therefore has the capacity to affect "a deep, structural shift in basic premises of [individual] thought, feelings, and actions [while causing] a shift of consciousness that dramatically and permanently alters our way of being in the world." (Transformative Learning Centre, 2013). It is the process through which our beliefs and attitudes, or our points of view and habit of mind are altered by critical reflection and discourse (Kitchenham, 2008; Merriam, et al., 2007; Moore, 2005).

These processes are summarized by Mezirow (1997) as "the process of effecting change in a frame of reference," (p. 5) which can be enacted through "critical reflection on the assumptions upon which our interpretations, beliefs, and habits of mind or points of view are based." (p. 7). Habits of mind, refer to "the deeply embedded assumptions that we hold," whereas a point of view is "an outward perspective that we take in response to a given life–world situation or set of circumstances." (Gunnlaugson, 2007, p. 136). Critical reflection can be broken down into three categories: (i) content reflection, examining an actual experience, (ii) process reflection, analyzing how to respond to the experience; and, (iii) premise reflection, questioning the "assumptions we hold regarding the self (narrative), the cultural systems in which we live (systemic), our workplace (organizational), or ethical decision making (moral-ethical), or feelings and dispositions (Merriam, 2004, p. 62). Critical thinking and reflection, is therefore the fundamental vehicle through which transformation occurs (Brookfield, 2003a; Malkki, 2011; Moore, 2005).

There is, however, a significant challenge to Mezirow's theory: it does not fully account for "the meaning of experience and the context in which it arises and by which it is interpreted," (Clark & Wilson, 1991, p. 76) and emphasizes the cognitive and rational aspects of transformation over the emotional and social dimensions (Malkki, 2011). As noted by Clark & Wilson (1991), sociocultural context is integral to Mezirow's transformative learning theory, but he leaves its effect on the individual psychological process largely unexamined. It is therefore important to realize that transformative learning has individual and social dimensions, and must promote conscientization, wherein individuals learn "to perceive social, political, and economic contradictions – developing a critical awareness – so that individuals can take action against the oppressive elements of reality." (Freire, 1970, p. 19).

This dissertation argues that for education to be transformative, it must first be critical. Without interrogating the social, political, and economic conditions in which an individual is situated, it is impossible to truly transform as a person. This is 'the social-emancipatory approach' to transformative learning wherein social change is the goal (Cranton, 2011), and critical reflection is connected to social action (Brookfield, 2003b).

This social perspective of transformative learning is highlighted by the change management literature as well, which discusses the transformative potential of change when diverse persons in an organization are seen, heard, and valued, and they are involved in instigating, implementing, or critiquing a change effort (Anderson, 2011; Cameron & Green, 2012; Carter, 2013). Essentially, what some change management theorists are arguing is best for creating change (inclusivity, diversity, and collaboration) align with a transformative, critical epistemology advocating the emancipation from structures that curtail personal autonomy through personal agency and community-based action.

2.5.1. Critical Pedagogy

Critical pedagogy has been woven together from several strands of thought, all of which share a fundamental view of theory and action as interlinked. Aristotle first spoke to the idea of there being three different types of knowledge, culminating in knowledge as praxis (Arnold, 2012). Centuries later Habermas categorized these three types of knowledge as *technical* (instrumental and empirical), *practical* (more communicative with social intent) and *emancipatory* (actively self-reflective, intended to liberate citizens from oppressive forces) (Habermas, 1971). The emancipatory capacity of learning was fundamental to the work of Paulo Freire, who was concerned with creating critical consciousness among oppressed persons through dialogue, reflection, and action (Kaufmann, 2010). Through class analysis, critical pedagogues began offering compelling insights and critiques into what education was, and what it could be. This critical discourse has since expanded to encompass all aspects of how economics, politics, and society operate to maintain the inequality of certain peoples, while facilitating the privileges of others, through education systems (Giroux, 2004; McLaren & Kincheloe, 2007). As higher education provision continues to be affected by neoliberalism, critical pedagogy remains a cogent force in interrogating how education systems can be liberating or oppressive.

Paulo Freire founded critical pedagogy by writing his landmark work *Pedagogy of the Oppressed* following the years he spent working with impoverished, illiterate persons living in Brazil in the 1960s. It was in this seminal work that the concept of the 'banking system' of education was established, along with the crucial revolutionizing of this system through 'education as a practice of freedom' which provided the necessary critique of, and solution to, the problem of traditional education. Freire first situates this discussion in a keen, unflinching assessment of how education has been used to prevent, not actualize human development. He argues that education is the vehicle through which oppression and subsequent dehumanization occur, because oppressed persons are essentially educated to accept and internalize the oppressor because ". . . *to be* is *to be like*, and *to be like* is *to be the like the oppressor*. . ." (Freire, 1970, p. 33). Crucially, he also argues that for there to be true liberation of oppressed persons, they must recognize themselves as oppressed and develop their own liberating pedagogy as “no pedagogy which is truly liberating can remain distant from the oppressed by treating them as unfortunates and by presenting for their emulation models from among their oppressors.” (Freire, 1970, p. 39).

A critical pedagogy therefore assumes that knowledge is political. The emancipatory function of critical pedagogy, as well as the development of critical consciousness, requires knowledge be interrogated, so it does not remain decontextualized and disconnected from the societal and institutional structures that control the means of knowledge production (Apple, 2010). A prevalent social structure that holds authority over knowledge is the university, and even when universities or actors within universities are open to critique, there are larger societal and institutional practices they are still subject to, which advantage some and disadvantage others (Giroux & Giroux, 2004).

First, universities are competitive. Intellectual ability is an important requirement to access it, but even so, universities are not meritocracies. There is inequality of access and resources leading into the university system and while inside of it (hooks, 2003). Second, education is a socially and culturally-bound practice. Because of this a student’s gender, race or ethnicity, can impact what type of educational choices they can/will make or training they can/will experience prior to attending university, and once enrolled may affect how they are perceived, taught, and evaluated (Eisenkraft , 2010). These factors and their effects are particularly relevant when looking at the sciences which are typically male-dominated outside of biology (Williams, 2015), despite strident efforts on behalf of universities (and often industry and government) to encourage higher rates of racialized

(Mayes, 2014), Indigenous (Aikenhead, 2002), and female student enrollment in STEM disciplines (Settles, 2006).

Indeed, women and international students remain minorities in engineering programs as well (Engineers Canada, 2014) indicating there are barriers to entering a Canadian engineering program, and remaining in it. It is important to identify what those barriers may be, as well as address any remaining issues students who do enroll in the sciences or engineering may face during their education. The following section provides a historical overview of engineering education in Euro-American universities. The theme of pedagogy is predominant, but change is a secondary thematic element as engineering pedagogy has experienced significant changes to its content, delivery, and evaluation methods since its addition to academia.

2.6. Engineering Education

Engineering education has developed immensely since the founding of the American Institute of Electrical Engineers and the Institute of Radio Engineers in the late 19th century, which merged together to form the Institute of Electrical and Electronics Engineers (IEEE) in the mid-20th century. The IEEE is now a global institution that is comprised of 395, 000 members in 160 countries, and has expanded its fields of interest beyond engineering to include modern technologies in general (IEEE, 2016). A major focus of the IEEE is the education of engineers and other technical specialists, whether that education happens prior to university, at university, or continues post-university (IEEE, 2016). Therefore, considerable scholarship, programming, and activities related to engineering education have been instigated, undertaken, or communicated through the various functions of the IEEE.

In 2012, the Editor-in-Chief of the IEEE journal "Transactions on Education", Jeffrey Froyd, who is an established scholar of engineering education, reviewed the developments in engineering education that have taken place over the last 100 years. He identified five major shifts that have, or currently are, changing engineering education (Froyd, Wankat, & Smith, 2012):

1. A shift from hands-on and practical emphasis to engineering science and analytical emphasis;
2. A shift to outcomes-based education and accreditation;
3. A shift to emphasizing engineering design;
4. A shift to applying education, learning, and social behavioral sciences research;
5. A shift to integrating information, computational, and communications technology in education.

Practical to Analytical

The first shift in engineering education began as European engineers who advocated mathematical modeling and theory-based curriculum immigrated to the United States in the early 20th century. This change towards a theoretical and analytical curriculum was further prompted by the Second World War and Cold War, as many American engineers were ignorant of the science underlying atomic weapons and space travel, and wartime research was therefore largely conducted by physicists, compelling a full-scale change in how engineers were educated (Froyd, et al., 2012). Engineering curriculum was evaluated by the American Society for Engineering Education in 1952, and resulted in the most influential document in modern engineering education, the "Grinter Report" which recommended that all engineering programs include a foundational curriculum in engineering sciences, plus coursework in the social humanities to understand the social and ethical ramifications of technological development (Grinter, 1955). This emphasis on scientific theory, and the humanities in engineering education, continues to be relevant and important components of engineering education as technologies become more complex and their impact on society more profound.

Outcomes-based Education and Accreditation

The second shift builds on the first by introducing an outcomes-based accreditation process to engineering education, to ensure engineering students are prepared for professional engineering practice upon graduation. These criteria evaluate technical components of engineering education, as well as its social and humanistic components. Euro-American countries have their own accreditation bodies, but there are shared criteria among them (ABET, 2016; ENAEE, 2016; Engineering Council, 2016). The Engineers Canada Accreditation Board (ECAB) oversees the accreditation of undergraduate engineering programs in Canada, which provide the academic requirements for licensure as a professional engineer in Canada. Its provincial and territorial regulatory bodies are responsible for the regional regulation of engineering education and the profession, as well as licensing engineering students as professional engineers upon graduation provided they meet the licensing requirements (Engineers Canada, 2016a).

The ECAB criteria specifies curriculum content, policies pertaining to student admissions, guidance, and graduation, as well as constant evaluation of programming, in its accreditation metrics. It is also very specific about the attributes students should be able to demonstrate upon graduation (ECAB, 2015):

- ***A knowledge base for engineering***: Demonstrated competence in university level mathematics, natural sciences, engineering fundamentals, and specialized engineering knowledge appropriate to the program.
- ***Problem analysis***: An ability to use appropriate knowledge and skills to identify, formulate, analyze, and solve complex engineering problems to reach substantiated conclusions.
- ***Investigation***: An ability to conduct investigations of complex problems by methods that include appropriate experiments, analysis and interpretation of data, and synthesis of information to reach valid conclusions.
- ***Design***: An ability to design solutions for complex, open-ended engineering problems and to design systems, components or processes that meet specified needs with appropriate attention to health and safety risks, applicable standards, and economic, environmental, cultural and societal considerations.
- ***Use of engineering tools***: An ability to create, select, apply, adapt, and extend appropriate techniques, resources, and modern engineering tools to a range of engineering activities, from simple to complex, with an understanding of the associated limitations.

- ***Individual and team work***: An ability to work effectively as a member and leader in teams, preferably in a multi-disciplinary setting.
- ***Communication skills***: An ability to communicate complex engineering concepts within the profession and with society at large. Such ability includes reading, writing, speaking and listening, and the ability to comprehend and write effective reports and design documentation, and to give and effectively respond to clear instructions.
- ***Professionalism***: An understanding of the roles and responsibilities of the professional engineer in society, especially the primary role of protection of the public and the public interest.
- ***Impact of engineering on society and the environment***: An ability to analyze social and environmental aspects of engineering activities. Such ability includes an understanding of the interactions that engineering has with the economic, social, health, safety, legal, and cultural aspects of society, the uncertainties in the prediction of such interactions; and the concepts of sustainable design and development and environmental stewardship.
- ***Ethics and equity***: An ability to apply professional ethics, accountability, and equity.
- ***Economics and project management***: An ability to appropriately incorporate economics and business practices including project, risk, and change management into the practice of engineering and to understand their limitations.

- ***Life-long learning***: An ability to identify and to address their own educational needs in a changing world in ways sufficient to maintain their competence and to allow them to contribute to the advancement of knowledge.

These criteria are like the American, UK, and EU accreditation criteria, with all bodies emphasizing theory, analysis, design, ethics, processing skills, and a commitment to life-long learning. In this sense, the criteria still reflect the same suggestions for engineering curriculum first laid out by the Grinter Report. Despite the demonstrated effect on improving engineering education, many professors still oppose assessing learning outcomes, and they undervalue or outright reject the social and humanist criteria considered integral to the engineering profession (Froyd, et al., 2012). Perhaps it is not surprising then, that research into engineering students and their capacity for ethical reasoning and critical awareness, as well as their understanding of social justice, has shown mastering humanist criteria to be their area of weakness (Cech, 2014; Finelli, et al., 2012; Harding, Carpenter, & Finelli, 2012; Tang, 2014).

A recent study, that collected data on engineering education at four separate institutions, tracked the importance engineering undergraduate students placed on their professional/ethical responsibilities, their understanding of the consequences of technology, their understanding of how people use machines, and their general social consciousness (Cech, 2014). The results suggested a culture of disengagement among the students in response to public welfare, and in fact, that their public welfare concerns declined significantly over the course of their studies. The potential for engineering to negatively impact society and the environment is why engineering accreditation bodies place importance on engineers understanding the ethical and social implications of their profession, and research into engineering education suggests that developing that understanding in engineering students remains challenging, and suggests that if this remains a tangential learning outcome it will continue to be a challenge.

Emphasizing Engineering Design

The third major shift in engineering education was a response to the initial shift towards science and mathematical theory and analysis. By the late 20th century engineering educators and practitioners began to emphasize the importance of design for engineering curriculum, as many students and young engineers did not have adequate design knowledge and skills (Froyd, et al., 2012). Prior to this, capstone design courses were encouraged by accreditation boards, but these happened in the final years of engineering education and were not integrated into all levels of the engineering curriculum.

Although these capstone design courses are still important curriculum components, there is a strong push to involve students in design from the get-go, with many engineering programs now offering a first-year engineering design course, or "cornerstone course" as they not only help students apply engineering science to design, but also have a positive influence on learning outcomes, attrition rates, and student engagement (Froyd, et al., 2012Unfortunately, there is still a lack of design emphasis in the second and third year of engineering curricula (Sheppard, Macatangay, Colby, & Sullivan, 2009), which has led to calls for linking theory to practice at all levels of the engineering curriculum (Kotys-Schwartz, Knight, & Pawlas, 2010) .

Applying Education, Learning, and Social-Behavioral Research

The fourth major shift in engineering education has been similar to the second shift: it is non-technical. In this case, however, the shift has not been about including humanities and social sciences in engineering curriculum, but using social sciences research to guide educational programming, assessment, and design. Research in behavioral psychology has resulted in learning objectives/outcomes, formative and summative assessment, and mastery model research outcomes and objectives. This impact is clearly demonstrated by the requirements that engineering students are expected to achieve desired learning outcomes as set by engineering accreditation regulatory bodies. Social psychology research has encouraged faculty members to employ teaching methods that help increase student engagement, such as active learning, interactive learning, and cooperative learning, which emphasize learning communities and communities of practice. These teaching methods also promote inquiry-based learning (such as problem-based and project-based learning) which promotes conceptual understanding.

These changes in teaching practice, as informed by cognitive psychology, education, and the learning sciences, have slowly been adopted by engineering faculty. Recent studies on engineering educators showing the majority know about student-centered pedagogies, learning communities and service-learning projects. Crucially, however, a minority of faculty utilize them (Froyd, et al., 2012). As social sciences research continues to inform engineering teaching practice and undergraduate programming, there is a corresponding development in how faculty understand and incorporates this research into their teaching practice.

Information, Computational, and Communications technologies

The fifth major shift in engineering education is concerned with the impact of technology on faculty teaching practice and student learning. This is an ongoing shift, as technologies used by engineers are continually developing. The most important aspect of this shift is surprising given the technical orientation of engineers and engineering education: students prefer human instruction over machine-mediated learning. This holds true even when students benefit from computer-aided instruction and/or learning more than personal tutoring or instruction (Froyd, et al., 2012).

The role of technology in engineering education has therefore largely been dominated by simulations and remote laboratories, which are used as professional tools, or personal response systems (i.e. 'clickers') that are incorporated into classroom based instruction. Technologies that deliver content, or provide individual student feedback and/or tutoring through teaching machines, have not proven popular among students despite their effectiveness. It appears that engineering students prefer learning through human-mediated methods, whether it is instructor-led or peer-based – which is a preference shared by other university students regardless of discipline (Paechter & Maier, 2010).

Summary

Despite these developments in engineering education, which have linked technical content to social and ethical learning objectives, this link remains tenuous because it is seen by some engineering educators to be tangential to teaching and learning in engineering programs, and undervalued by engineering students. Strengthening this link may only happen if the divide between the sciences and the humanities is broken down, allowing engineering educators and students to see the value of the humanities to their teaching and learning as engineers. The next section reviews this divide between the sciences and the arts, and argues for a critical engineering education that subverts this divide to the benefit of engineers and non-engineers alike.

2.6.1. Critical Engineering Education

The more universities continue to be shaped by neoliberal discourse, and the more they become rigidly constrained by the manufacture and production of knowledge (Hardt & Negri, 2000), the further entrenched the binary between the sciences and the arts becomes. It is scientific knowledge that has become economically valued within our contemporary world of advanced technology (Day, 2007; Fins, 2010; Kent, 2012; Rowe, 2007), and science has become synonymous with progress and profitability (Fins, 2010; Snow, 1959).

Because the current economic and ideological discourse places higher value on applied scientific and technical knowledge (Dass, 2008; Davidson, 2011; Rowe, 2007), the entrenched schism between the humanities and the sciences is maintained. However, many scholars argue this is limiting (Bibeau, 2011; Brown, 2011; Corrigan, 2012), because it applies epistemologies of empiricism and objectivity to social issues which are innately subjective, and it denies subjectivity in STEM disciplines which could benefit from humanist insights (Garland, 2012; Wierzbicka, 2011). For example, the highly technical knowledge that is needed to understand blood sugar regulation and insulin therapy is as necessary to Type 2 diabetes treatment and prevention as is research that examines social factors that contribute to Type 2 diabetes and designing social programs that enable disease prevention.

Not only are the humanities undervalued in the neoliberal framework, scientific knowledge has become increasingly valued for its commercial potential, which limits scientific discovery and progress (Franklin, 2000; Turk, 2000; Turk, 2010). For example, many important scientific discoveries (x-rays, trains, atomic energy, fax machines, to name a few) were not valued at the time of their invention because they did not directly exhibit commercial usability. Clearly, however, these products of science have allowed humanity to progress in ways unimaginable due to their influence in developing modern medicine, manufacture, mechanization, and digitization. Furthermore, they are now commercial goods. Whether the basic research necessary to discover the science behind these applications would have been funded under the current federal funding structure is questionable.

Engineers are particularly powerful in our technologically advanced world because of their ability to apply mathematics and scientific theories to the physical world, and in turn shape that world through the manufacture and production of knowledge. Simply put, engineers invent commodities. However, the technologies they create are more than commercial goods: they can have significant effect on human life and society. Therefore, the role of engineers in society will only become more important as our societies, economies, and environments continue to be mediated by technology.

Science and technology can be a positive force in society, but it can also create a culture of compliance, wherein the values of technology have "so permeated the public mind that all too frequently what is efficient is the right thing to do" (Franklin, as cited in Ballie & Catalano, 2009a, p. 25). This culture of compliance means people become accustomed to using and being used by technologies and lose their capacity to engage with technology critically or make choices on if and when we engage with technology. [15]

Franklin (2000) however, argues individuals do have choices, and when persons such as engineers go to create new technology they should ask themselves, does it promote a just, human-centered, holistic, and environmentally sustainable ethos? Can it be reversed? Does it minimize the possibility of waste or disaster? Does it protect common social goods, such as clean air and water? Can it be engaged with by the people it affects? (Ballie & Catalano, 2009a). These questions are important for engineers to ask because even though social and environmental problems could be solved by technical means, they can also be caused by technical means. That is why educating engineers to be aware of the ethics of their work, not only proficient scientists and technicians, is such an important aspect of engineering education.

This study proposes that educating engineers to address these ethical questions take place through a critical pedagogical framework, resulting in a critical engineering pedagogy that moves beyond scientific thinking and problem-posing. Byrnes and Dunbar (2014) discuss scientific thinking and problem-posing as elements of critical thinking, but argue problem-solving, deductive and inductive processes are not synonymous with critical

[15] The idea that technology is not a tool that is used by human beings, but instead is a force that directly affects and shapes human behaviour and society, is known as *technological determinism* (Kte'pi, 2011).

thinking. Instead, they hold it is possible to engage in problem-solving and scientific thinking without ever undergoing a critical thought process (Brynes & Dunbar, 2014) because it is possible to possess the cognitive skills associated with critical thinking and lack the disposition to learn about or discuss social issues (Abrami, et al., 2015). Therefore, the development of both critical thinking skills *and* dispositions are necessary to develop critical thinkers.

According to the Delphi consensus panel on critical thinking[16], there are 6 critical thinking skills and 19 critical thinking dispositions (Facione, 1990):

Cognitive skills and subskills:

- Interpretation: categorization, decoding significance, clarifying meaning
- Analysis: examining ideas, identifying arguments, analyzing arguments
- Evaluation: assessing claims, assessing arguments
- Inference: querying evidence, conjecturing alternatives, drawing conclusions
- Explanation: stating results, justifying procedures, presenting arguments
- Self-Regulation: self-examination, self-correction

Approaches to specific issues, questions, or problems

- Clarity in stating the question or concern

[16] In 1990 the American Philosophical Association funded a two year research project on determining core critical thinking skills. They assembled a panel of 46 experts within the US and Canada, representing disciplines in the humanities, sciences, social sciences and education and conducted a Delphi study, which is a widely used and accepted method for gathering data from respondents within their domain of expertise, disciplines, or areas where scientific laws are still under development.

- Orderliness in working with complexity
- Diligence in seeking relevant information
- Reasonableness in selecting and applying criteria
- Care in focusing attention on the concern at hand
- Persistence though difficulties are encountered
- Precision to the degree permitted by the subject and the circumstance

Approaches to life and living in general

- Inquisitiveness with regard to a wide range of issues
- Concern to become and remain generally well-informed
- Alertness to opportunities to use critical thinking
- Trust in the processes of reasoned inquiry
- Self-confidence in one's own ability to reason
- Open-mindedness regarding alternatives and opinions
- Understanding of the opinions of others
- Fair-mindedness in appraising reasoning
- Honesty in facing one's own divergent world views
- Flexibility in considering biases, prejudices, stereotypies, egocentric or sociocentric tendencies
- Prudence in suspending, making, or altering judgments
- Willingness to reconsider and revise views where honest reflection suggests change is warranted

Many of these skills and dispositions are already used by and adopted by engineers, with major projects and initiatives now taking place within engineering education that are focused on taking a critical approach to engineering curriculum, by situating it in the larger global contexts in which it exists. For example, David Goldberg and Andreas Cangellaris, both prominent engineering educators and practitioners, co-founded a cross-disciplinary 'curriculum incubator', known as the Illinois Foundry for Innovation in Engineering Education (iFoundry), in the College of Engineering at the University of Illinois in 2007 (Pitts, 2017). The aim of this program was to facilitate engineering educators in "redesigning their courses by using instructional contexts that allow students to see meaningful relationships between abstract ideas and practical applications." (Rosu, et al., 2014, p. 54).

Goldberg has since gone on to establish the Big Beacon Project[17], which calls for a whole-scale change engineering pedagogy. The emphasis in this project has further progressed the work he did at iFoundry, calling on engineering educators and programs to dramatically redesign their entire approach to educating students, and offers 12 characteristics of 'a whole new engineer', 12 characteristics of a 'whole new engineering education' and 5 aspects of 'effective educational change'. This call for action is a clear response to, and rejection of, traditional engineering pedagogies and discourses. Instead, it is arguing for a critical, reflective, socially and ethically conscious engineering practice and practitioners[18]. Indeed, the book Goldberg went on to write with his colleagues Mark

[17] Further information on the Big Beacon Project is available at http://bigbeacon.org. The full 'Big Beacon Manifesto' is available at bigbeacon.org/big-beacon-manifesto.pdf

[18] From here on out, this type of pedagogical approach to engineering will be referred to as a 'critical engineering pedagogy'

Somerville and Catherine Whitney about their collective experiences introducing this type of pedagogical approach in the engineering programs at Olin College and the University of Illinois, explicitly states their objective to change the status quo in engineering education, moving it from a narrow focus on technical education and a transmission lecture model to an emotionally and socially engaged practice that is student-centered (Goldberg, Somerville, & Whitney, 2014; Goldberg & Somerville, 2015).

The Big Beacon Project was an open call, broadcasted globally, to all university engineering programs, and its Education Innovators Working Group currently comprises universities from North and South America, Asia, Britain, and the European Union. There is also a globally recognized commitment among the engineering establishment, which is broadly taken up by undergraduate engineering education programs, to address the 'Grand Engineering Challenges'. These are fourteen problems[19] engineers have posed as a community to solve for the betterment of humanity and the environment. This type of socially-oriented, humanitarian engineering is also the focus of work that is undertaken by Engineers Without Borders[20], which is also broadly taken up by engineering students either as individuals or collectives on their respective campuses. There are over 40 Canadian chapters, in every province (Engineers Without Borders Canada, n.d.).

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[19] The 14 Grand Engineering Challenges are: Make solar energy economical; Provide energy from fusion; Develop carbon sequestration methods; Manage the nitrogen cycle; Provide access to clean water; restore and improve urban infrastructure; Advance health informatics; Engineer better medicines: Reverse engineering the brain; Prevent nuclear terror; Secure cyberspace; Enhance virtual reality; Advance personalized learning; Engineer the tools of scientific discovery. (More information on the challenges are available at www.engineeringchallenges.org).

[20] For more information on the work Engineers Without Borders undertakes internationally, see http://ewb-international.com

Not only are critical thinking skills and dispositions taken up by the above initiatives in engineering education, they are also enshrined in the ECAB criteria which summarizes the concerns of the engineering establishment around curriculum content and objectives, such as problem analysis, investigation, teamwork, communication, ethics and equity, and the impact of engineering on society and the environment (2015). However, as is recognized by engineering themselves (Cech, 2014; Finelli, et al., 2012; Harding, Carpenter, & Finelli, 2012; Tang, 2014), more can be done to educate engineering students beyond establishing a discipline-specific critical thinking skill set, so they can also adopt general critical thinking dispositions that account for the wider social and ethical questions and issues that their work is impacted by, and which it in turn impacts. As Goldberg, Somerville and Whitney (2014) would argue, this has not yet been done in meaningful way across the majority of engineering programs.

At present, there is some work being done on this at Maple University, but it is relegated to two courses, which run for one semester each, during the junior and then senior engineering course schedule. This course is the only course specifically designed to account for the non-technical aspects of engineering, and primarily focuses on team work, communication skills, the impact of engineering on society and the environment, and professionalism. The teaching methods include reflective learning, but do not have a clearly communicated critical pedagogical intent (as communicated on the course outlines[21]) and there is little to no meaningful discussion of disenfranchised peoples within the profession or affected by it. Finally, and unfortunately, the peer mentor

[21] Course outlines are not made available here as including them might compromise the anonymity of the research site given the courses are specific to Maple University.

research participants in this study reported that these courses are not positively received by the students[22]. Therefore, more work needs to be done to expand the critical content of these courses to reflect the socio-economic power discourses that engineering affects and is affected by, and to better engage students[23]. Developing a critical engineering pedagogy is especially pressing because some of the Grand Engineering Challenges have a direct impact on racialized cultures and countries, and engineers must be able to think critically about these cultures and countries, so they do not perpetuate neo-colonial practices and Eurocentric discourses that disenfranchise racialized peoples. The following section explores the diversity and inclusivity issues troubling engineering education, looking at the experience of women, racialized, international, and Indigenous students within universities generally, and where possible, engineering specifically. Doing so demonstrates the need for a critical engineering education that recognizes and engages with the social, cultural, and historic complexities that positivism has had on who is can become a university graduate and/or an engineer. Interrogating these power dynamics is one of the central aims of critical pedagogy, as is the emancipation of persons from oppressive discourses (Kincheloe, 2004). Therefore, the following section is primarily focused on agency, examining how the agency of certain university students (and faculty) is curbed by the organizational culture of universities and education systems generally, that are founded on a specific discursive notion of who can know and what can be known.

[22] See Chapter 6.
[23] I am not suggesting that the two non-technical engineering courses at Maple University are not attempting to engage students and introduce a critical discourse, but I recognize how difficult and challenging this work is given one of the dominant engineering discourses rejects subjective, philosophical, and critical inquiry and focuses on technical, objective, post-positivist knowledge and theory.

2.7. Engineers, Education, and Equity

Arguably, engineering education shifted over the 20th century due to a corresponding shift within Euro-American society through various civil rights movements that sought to empower previously disenfranchised social groups, such as women, ethnic minorities, as well as gender/sexual minorities. At the same time, the world rapidly globalized, with international student movement quickly increasing. As discussed at length already, these social, political, and economic movements have come to define the postmodern era. That has opened engineering study and work to women, ethnic minorities, and gender/sexual minorities. However, engineering continues to be oriented around a heteronormative, hegemonic, masculinity, (Bix, 2004; Editor, 2002; Ekoniak, 2013; Frehill, 2004; Mayes, 2014) despite large-scale social changes that have begun diversifying engineering student demographics, the commitment engineering accreditation bodies have made to recognize that reality, and the research socially-minded engineers have contributed to engineering pedagogy (Ballie & Catalano, 2009b; Catalano, 2006; Catalano, 2009).

Dr. Erin Cech, an engineer and sociologist who specializes in gender, science, and technology studies, argues that engineering culture is routed in three ideological pillars that act to devalue concerns about social justice, inequality, and morality in relation to engineering practice: the ideology of depoliticization, which frames any ‘non-technical’ concerns such as public welfare as irrelevant to ‘real’ engineering work; the technical/social dualism, which devalues ‘social’ competencies such as those related to public welfare’ and the meritocratic ideology, which frames existing social structures as fair and just (2014). This characterization of engineering culture as technically-oriented and politically and socially unsophisticated, is also discussed by other researchers and has been established by various studies of engineering education and the engineering profession (Babaci-Wilhite, 2016; Faulkner, 2015; Tang, 2014).

This culture originates in engineering undergraduate programs, and remains problematic within professional engineering communities, thereby affecting students even after they graduate and become professional engineers. These effects are significant for students who do not conform to dominant engineering cultures (Bix, 2004; Dutta, 2016; McGee & Martin, 2011; Yoder & Mattheis, 2016). Even when students do conform to cultural norms and expectations of their peers and instructors, there are still certain students that remain ousted from the fold. Those students are typically women and/or visible minorities and/or queer[24], because the unspoken and tacitly assumed prototypical engineer is white, Western, English-speaking, heterosexual and male (Cech & Waidzunas, 2011; Riley, 2008).

Therefore, it is not surprising that engineering students find it challenging to master the humanist criteria expected of them by their respective national accreditation boards, given the lack of importance placed on these criteria by their professors (many whom are prototypical engineers themselves), and the relative unimportance a critical, political,

[24] "Queer, in sexual politics, is a description of sexuality that rejects normative definitions of appropriate feminine and masculine sexual behaviour. More contemporary meanings of queer have been picked up and used by activists and academics to mark movements within sexual identity politics and theoretical frameworks for understanding gender and sexuality. Queer, however, is a contested term: scholars and activists constantly disagree on what queer means and the way in which it should be used." (Hidalgo & Barber, 2017). In this thesis, I use 'queer' as an umbrella term to denote persons who identify as lesbian, gay, bisexual, transgender, asexual, etc. I realize that this term can be considered offensive depending on a person's cultural standpoint, given its past derogatory usage. However, I am deliberately using the term as part of the reclamation movement around the word 'queer' that has happened in North America and among young persons in the UK (Rand, 2015).

emancipatory knowledge brings to their lives given that they benefit from the status quo. Challenging systemic sexism, racism, and homophobia, within engineering culture is important to best support the women, ethnic minorities, and gender/sexual minorities, studying undergraduate engineering. Unfortunately, research on social minority groups in Canadian engineering programs is limited. There are good statistics on female enrollment numbers, as well as international student enrollment. However, there is less information on ethnic minorities (which should not be conflated with international students, as white European or American students are also classified as 'international'), Indigenous students, and queer students. The available data therefore only provides a partial picture of engineering students in Canada.

Currently, there are 14,468 women enrolled in engineering programs in Canada, accounting for 19.1% of all engineering undergraduate students (Engineers Canada, 2014, p. 12). Provincially, there is a lot of variation: PEI has the lowest percentage of female enrolment numbers, at 8.3%, and Newfoundland has the highest percentage at 24.3%. Both provinces, however, also have the lowest numbers of overall undergraduate engineering students, with a total of 120 engineering students in PEI, and 989 in NL, which reflect the smaller general student populations in both provinces (Engineers Canada, 2014, p. 23). Female student enrolment numbers peaked in 1999 at 20.6%, then declined to 17.8% by 2008 (Engineers Canada, 2014, p. 3). The trend, however, is moving up again. Despite this positive trend seen in female student demographics, female faculty continue to significantly lag behind male faculty. There are 184 full female professors to 1767 full male professors, and 187 female associate professors to 1001 male faculty of equivalent rank (Engineers Canada, 2014, p. 51). Worryingly, this trend looks set to continue with only 139 female assistant professors as compared to 483 male assistant professors, meaning there is already less women in the system eligible for future academic promotion.

In terms of international students, there are currently 11,321 international engineering undergraduate students across Canada, which accounts for 15% of all engineering undergraduate students nationally (Engineers Canada, 2014, p. 13). Evidentially, the push to enroll increasing numbers of international students has worked, as since 2010 international students have accounted for 49.6% of the growth in engineering undergraduate student enrolment. Again, the provincial percentages vary, with Newfoundland enrolling the least number of international students, at 10.3% of total engineering students, and PEI enrolling the most, at 25%. There are no official numbers on the ethnic make-up of engineering student or faculty members, or the percentage of Indigenous students enrolled in engineering programs at Canadian universities (J. Ricci, personal communication, May 10, 2016).

Engineers Canada, which oversees engineering education and the engineering profession in Canada, does not collect statistics on Indigenous students and faculty, and/or queer students and faculty, and therefore there are no official numbers for either group. Unfortunately, these statistics are hard to collect, as in general, university students and faculty prefer not to self-identify as Indigenous and/or queer given the discrimination within the academy generally, and STEM specifically, towards ethnic and gender/sexual minorities (Bilimoria & Stewart, 2009). This is further exacerbated by the exclusionary nature of engineering culture, which is either indirectly or directly hostile to persons with a non-binary gender or sexual identity (Cech & Waidzunas, 2011; Ekoniak, 2013; Yoder & Mattheis, 2016), and is predicated on a scientific perspective that devalues and excludes Indigenous knowledges (Aikenhead, 2002). There is also limited research in both areas, which makes it that much more difficult to formulate a comprehensive picture of what Indigenous and/or queer students who are in engineering experience within an environment that assumes a heteronormative, white, Western, perspective. What research is available is discussed in the following sections on women, racialized, international, and Indigenous students, in universities and the sciences generally, and engineering specifically where possible.

2.7.1. Women

Julie Kristeva, a structuralist feminist, positions the feminist struggle for social, political, and economic equality within a three-tiered evolutionary process wherein: (i) women push for equal access to areas previously open only to men; (ii) women then extol the virtues and strengths of women and from this wave of feminism emerges the *superwoman* who has and does it all well, from doctoral studies to research to work to marriage to family; and, finally (iii) a newly reconfigured space is established wherein the notion of gender identity is challenged (Kristeva, 1981). For example, in relation to women in the sciences, that end stage would not simply ask what it means to be a woman in science, but also how science is practiced, to what end, serving what objectives (Rayman & Stewart, 2000).

Applying this evolutionary process specifically to the trajectory of women in science, Rayman and Stewart (2000) pulled historical data on the numbers of women who first entered the sciences and the disciplines they chose, highlighting the fact that even once women had access to science education and careers unheard of before the Education Amendments of 1972, and the Engineering Equal Opportunities Act of 1980, that access is not equality. In fact, this access created an impossible position for women as they were judged against two separate standards: the professional and the mother. Perfection was demanded of each role, creating the illusory and ultimately self-defeating 'superwoman' that placed female scientists (alongside career-focused women in other professions) under intense pressure to be an ideal mother while simultaneously outperforming their male peers just to be accepted within traditionally male-dominated professions. Attrition rates in science education and professions were therefore high, participation rates were still low, and they largely remain as such today (Shen, 2013).

Therefore, the third stage Kristeva envisioned for the feminist struggle is yet to be realized. What it means to be a woman in science is to live, think, and act like a man in so much as career trumps family, emotion is not incorporated into work, and competitive success is tantamount. What it means to practice science is to adopt, accept, and act within an Occidental post-positivist epistemology. Indeed, these characteristics of science and how it affects all persons who participate in it is a common theme across the literature on women in STEM (Bastalich, et al., 2007; Faulkner, 2000) and requires a consciousness of the limitations this can impose on building inclusive scientific communities.

One of the limitations to building an inclusive science community discussed by Bix (2000) in a historical account she gives of women entering and achieving access to MIT, is the nature of academia itself, and how its regulations and procedures can actively discourage or prevent women from being successful. This is especially true for women in graduate level sciences, as they are beholden to existing processes (particularly the graduate advisor-advisee relationship) that primarily benefit men and male faculty as it is primarily male faculty members who have access and control over resources (i.e. graduate funding) and authority for making decisions (i.e. completion of graduate degree) – and they are biased in favour of other men (Fox, 2000).

It is not only female students that are held back by the structure of academic science, but also female faculty. For example, Grant, Kennelly, and Ward (2000) discuss how university science is a ‘greedy institution’ in the sense that it demands total commitment from participants and “its claims on individuals become ever more stringent as time passes and as individuals move to higher positions within it. The control is symbolic, based on perceptions that participation in such institutions is highly desirable.” (p. 65). This becomes a great barrier to female scientists who have (or desire) marriage and children as “certain forms of scientific work, the reliance on continual and unbroken external funding, and the organization of research and training make it difficult to take time off or cut back on work temporarily to fulfill family demands and still survive in science.” (p. 83).

As Fox (2000) notes, however, when concluding her research on the status of graduate women in science studies at sixteen universities across the United States, “a fundamental feature of existing social structures is that some groups benefit, and others do not. In science and engineering, men, and particularly male faculty, have been more likely to benefit from existing arrangements; and, in comparison, women as a group have not. Most men do not consciously oppose equality for women . . . however, it is important to understand that in organizations and occupations, incentives exist to preserve current, advantaged positions and distribution of valued resources." (p. 58). The low statistics on female faculty in Canadian universities arguably demonstrate this reality, as does the messaging from Engineers Canada, which wants more women in engineering, but whose Board of Directors features 3 women to 18 men, and 4 male special advisors to the board (Engineers Canada, 2016a).

Therefore, even if there is more general awareness of the issues experienced by women in science, resulting actions are curtailed by incentives to preserve the status quo, even when the conscious intentions of those in positions of power support change. For example, in the case of female faculty and their personal decisions to marry or have children, social expectations are still such that those who pursue motherhood alongside their academic careers are still expected to achieve the 'superwoman' ideal put forward, as universities are not motivated to restructure the current system to better accommodate women. When accommodations are made, or special programs are put in place for women in order to offset the predominance of men within academia and science professions, female scientists report they fear they will be judged as inferior to their male colleagues and thus discredited. This is especially concerning for them given the long struggle to simply access science education and professions.

Benckert & Stanberg (2000) examined the reactions of female faculty in Sweden to a special allotment of professorships sponsored by the national government and intended for qualified female scientists (as judged against male applicants who could also apply and receive the professorships) finding most of the female scientists they spoke to were opposed to this affirmative action because it called into question their abilities to practice science as well as men. These concerns were also noted by the majority of twenty-eight female scientists at American universities who were interviewed about their opinions on feminism and women in science (Ginoria, Marshall, & Breckenridge, 2000). Both the Swedish and American interviewees noted, however, the continued challenges to equity for women in academic and professional science careers and cited that as a major concern.

These concerns are not unfounded, given the fact female science students, academics, and professionals still face comments that they are only in their positions due to affirmative action (Bix, 2004; Fox, 2000; Ginoria, Marshall, & Breckenridge, 2000; Margolis, 2000). Benckert and Standberg (2000) caution, however, that "gender matters to women scientists, independent of their attitude toward gender or feminist questions, both because they work in a male-dominated culture and because of this culture's symbolic value in society." (p. 99). Although some women manage to overcome these constraints, judging by the high attrition rates among women from science disciplines and professions (Rayman & Stewart, 2000), problems still exist. The institutionalized inequity of women in science, mathematics, and engineering, is important to this study, because it makes the limitations of traditional engineering pedagogy visible. It also illustrates the relative lack of agency women have within STEM disciplines, and the difficulties to changing its patriarchal culture.

The following section discusses the institutionalized inequity experienced by racialized peoples within academia, showing how universities can be unwelcoming places not only to women, but to racialized persons, as well as Indigenous peoples and their epistemological traditions.

2.7.2. Ethnicity

Discrimination in STEM disciplines extends beyond women, to racialized persons and/or peoples with a non-Western epistemological heritage. Because the traditional university paradigm is predicated on a power structure that rewards conformity, it is subsequently invested in keeping people out who do not conform – being anyone who conducts research and teaches from a standpoint that is not middle-upper class, white, and masculine – or normalizing them into the hegemonic university discourse so they adopt an acceptable standpoint. Although there have been – and continue to be – attempts to revolutionize the traditional university discourse, it is still largely defined by a strong hierarchical structure that is supported by an exclusionary and judgmental discourse that is normalized within its operations and across its membership. The university is supposed to be a place that critically engages with knowledge, but often it becomes a place where knowledge is passively accepted.

bell hooks, a critical feminist scholar, writes about this silencing of diverse voices in the one social space they are supposedly encouraged throughout her various publications on pedagogy and higher education, having studied and taught at Ivy League schools which offer the ideal higher education model (hooks, 1994; hooks, 2003, hooks, 2010). She approaches the issue from the standpoint of a black, feminist, working-class, woman. Her critique of university education is informed not only by that standpoint, but also her intimate connection to the legacy of racism, segregation, and slavery in the Southern United States, which provides an even more nuanced critique of Euro-American institutions of higher education.

She argues that even though the civil rights movement of the mid-20th century has matured, there has been little change in university discourses. For example, the Western canon is still upheld as the most (or only) valid intellectual tradition in the arts, and Western scientific methods are situated as the most (or only) valid intellectual traditions in the sciences. Although she recognizes the impact cultural diversity has had on traditional university discourses, she argues it is a superficial change, using the response of the university community to persons of color in the academy to exemplify this insincere acceptance of cultural diversity:

> Often individual black people and/or people of colour are in settings where we are the only colored person present. In such settings, unenlightened white folks often behave toward us as though we are the guests and they the hosts. They act as though our presence is less a function of our skill, aptitude, genius, and more the outcome of philanthropic charity. Thinking this way they see our presence as functioning primarily as a testament to their largesse; it tells the world they are not racist. . .unaware whites, often liberal, saw and see their interactions with people of color via affirmative

> actions as an investment that will improve their lives, even enhance their organic superiority. . .To raise the specter of racism in the here and now, to suggest that despite their political beliefs and sexual preferences, white people operate within, and benefit from, white supremacist social structures is till tantamount to a declaration of war (hooks, 2003, p. 34-35).

Just as access to STEM disciplines do not equate to equality for female scientists and engineers, nor has access to the academy magically undone the effects of institutional racism, in fact it has helped silence the discussion of racism. hooks (2003) talks extensively about how the university community (and society at large) does not want to engage with discussions of racism, believing racism is no longer present in the Euro-American societies because it is no longer overt, publicly approved, and legally-sanctioned. Having those discussions are uncomfortable and challenging, provoking anxiety, defensiveness, or detachment (Allen, 2006). However, those discussions are necessary. Racism may no longer be socially-condoned, but that does not mean we live a world that still does not operate through racist assumptions – they are just less visible, and have become systemic. The irony is now that racism is less visible (or only vocalized by far-right fundamentalists) it becomes that much harder to challenge it – especially when the current discourse on race assumes a post-racism perspective (Goldberg, 2005).

Bonilla-Silva and Embrick (2006) argue that this unwillingness to recognize racial discrimination is a product of a colour-blind racism, which they define as ". . . practices that are predominantly subtle, institutional and apparently non-racial." (p. 23). They delineate four central frames of colour-blind racism: (1) abstract liberalism, (2) naturalization, (3) cultural racism, and (4) the minimization of racism (Bonilla-Silva & Embrick, 2006, p. 23):

1. Abstract liberalism reframes race issues in the language of political and economic liberalism, wherein free market ideology comes to bear on racial issues such as hiring decisions or university admissions – the choice is between competing applicants and decisions are made on the relative merit of one over another –the de facto racism that influences who will be selected, or even who will have the opportunity to be in a position to be an applicant is not considered.
2. Racist actions or opinions are further normalized through an appeal to people's 'natural inclinations' to group like with like, so the lack of meaningful integration of different races is explained away by simple explanations about natural preferences associated with members of your own race.
3. This engenders cultural racism, wherein the traditional (and now politically incorrect) notion of minorities being biologically inferior has shifted so that it is their cultural practices that are to blame for their inferiority.
4. Cultural racism leads to the assumption that the low-status of minorities ". . . is the product of their lack of effort, loose family organization, inappropriate values, or some combination thereof." (Bonilla-Silva & Embrick, 2006, p.25). Essentially, racism as an active condition affecting minorities is minimized – and attributed to concepts perceived to be outside white control, or placed back onto those being discriminated against.

Bonilla-Silva and Embrick (2006) are not the only scholars to demonstrate that societies are not meritocracies and refute the myth of post-racial societies or university institutions (Colin & Lund, 2010; Lee, 2007; Eisenkraft, 2010; Sue, et al., 2007). Their framework is similar to the concept of neo-racism, wherein the scientific racism of the past has been replaced with a racism that is predicated on a belief in immutable cultural differences (Henry & Tator, 2010). Colour-blind, or neo-racism, is perpetuated by the liberal ideology that unless there is an intention to be racist, then racism does not exist (Henry & Tator, 2012).

In fact, a study published in 2014, discussed the racial views and experiences of 12 white men at an American university. Not only did they deny racism existed, but they identified themselves as the victims of ‘reverse racism’. As there was a high level of racial segregation in their pre-university and university environments the participants did not see evidence of overt racism, therefore they doubted its existence and thus minimized the effects of racism towards people of colour. The researcher noted, “Within this context, anything race conscious becomes equated with ‘reverse racism’ including race-specific scholarships and affirmative action. This misunderstanding of the nature of racism further entrenches the sense of victimization, building increased hostility toward multiculturalism and people of color.” (Cabrera , 2014, p. 32). This study reveals a growing trend among white Americans to claim they are victims of racism (Blake, 2011; Norton & Sommers, 2011; PRRI, 2014) even though there is no statistical evidence for this assumption (Norton & Sommers, 2011). The trend is not limited to the United States, with research out of the United Kingdom carried out by the national government in 2008 also reporting at least 29% of white British believe they are victims of racial discrimination (BBC, 2009; Summers, 2009). The issue had already gained national media attention, with the BBC releasing a special report called “White Season” (Long, 2008) following up a survey they conducted on British attitudes towards race and discrimination (BBC, 2008).

This trend to claim whites are racialized has not extended in any popular sense within Canada, however, non-racialized Canadians often still buy into the myth that we live in a post-racial society. This is particularly true of Canada, which prides itself on being a liberal, multicultural nation that does not discriminate against persons of colour (Eisenkraft, 2010; Poolokasingham, et al., 2014). This is clearly untrue. You only have to look at how Canada treats is Indigenous peoples to see the impact of systemic racism (Glimore, 2015), which is an issue that will be explored at length in the following section on Indigenous students. Narrowing down the scope on racism to the university specifically, an institution which prides itself on values of openness and merit, racism persists. According to the 2006 Census, about 14 percent of faculty positions are held by visible minorities, whereas 24 percent of all persons with PhDs in Canada are visible minorities (Statistics Canada, n.d.). These obvious discrepancies between education level and employment levels suggest that racialized faculty are targets of systemic discrimination. Indeed, research on racialized faculty at Canadian universities has shown the realities of the institutional racism are significant within the academy in Canada.

Racialized faculty have been mistaken for cleaning staff, or their credentials are met with incredulousness from other faculty, they are ignored in meetings, they are seen as objects of study (i.e. their cultural heritage is exoticized), and they have difficulty achieving tenure and promotion relative to their white peers (Eisenkraft, 2010). These daily microaggressions[25], cause feelings of loneliness and alienation among racialized faculty, especially given the emphasis of Eurocentric curriculum, and the devaluing of critical, applied, and community research (Henry & Tator, 2012). The practices of the university in general are also a point of concern, with faculty noting that important positions in senior administration are often staffed by white men, and departmental managers are insensitive to minority faculty needs (Henry & Tator, 2012). These comments from racialized faculty characterize institutional racism, which can be defined as “the intentional or unintentional manipulation or toleration of institutional policies that unfairly restrict the opportunities of particular groups of people,” which is particularly insidious because it involves the adverse behavior of organizations or institutions, not just individual persons (Ridley & Kelly, 2006, p. 256).

In terms of racism within engineering culture specifically, much of the available research comes from a series of publications on engineering, ethics, and society, known as *Synthesis Lectures on Engineers, Technology and Society*[26]. The authors of these publications are established engineering educators, such as: Caroline Ballie, Chair of Engineering Education at the University of Western Australia, and founder of the Engineering, Social, Justice and Peace network; George Catalano, Undergraduate

[25] Racial Microaggressions refers to a tripartite model consisting of (i) subtle communications that marginalize the perspectives and experiences of people of colour, (ii) inconsiderateness or disrespect of people of colour, (iii) overt racist attacks (Sue, et al., 2007).
[26] Note from series editor, Caroline Baillie: “The mission of this lecture series is to foster an understanding for engineers and scientists on the inclusive nature of their profession. The creation and proliferation of technologies needs to be inclusive as it has effects on all of humankind, regardless of national boundaries, socio-economic status, gender, race and ethnicity, or creed…The lectures will be relevant to all engineers practicing in all parts of the world…The goal of the series is to provide a platform for the publication of important and sometimes controversial lectures which will encourage discussion, reflection and further understanding.” (Catalano, 2006, p. i).

Program Director of Engineering at Binghamton University and key contributor to the discussion of socially just engineering, and; Donna Riley, Associate Professor of Engineering at Smith College, and active in adapting critical pedagogy to engineering curriculum. The *Synthesis* series applies a critical perspective to different social justice topics, such as the impact engineering has on local and global societies, environments, and economies (Ballie & Catalano, 2009a; Ballie & Catalano, 2009b; Catalano, 2009). It also explores engineering in relation to human conflict, poverty, and underdevelopment (Catalano, 2006).

Relevant to the discussion on engineering culture and racism in *Engineering and Social Justice*, is a contribution to the series by Donna Riley. She covers various topics additional to race, such as neo-colonialism (which is closely tied to race issues), social class (also closely correlated with racial discrimination), sexism, homophobia, and political conservatism among engineers. The discussion of race is foregrounded by a review of engineering culture as an exclusive space that operates through a specific type of engineering discourse that is mechanistic, reductionist, and uncritical of authority and established power structures in society (Riley, 2008). Unlike the engineering discourse advocated by engineering educators, programs, and organizations, previously described in Section 2.6.1: Critical Engineering Education, this engineering discourse is not open to discussions of social justice, nor does it place value on social justice objectives[27]. Riley summarizes this discourse as follows:

[27] The engineering discourse discussed in Section 2.6.1: Critical Engineering Education will herein be referred to as a critical engineering discourse, which is characterized as socially-engaged, ethically-aware, and outward looking. This is contrasted to more traditional engineering discourses and engineering cultures,

> Engineers and the engineering profession have some characteristics that prepare us well to work on social justice issues: the strong desire to be helpful and the persistence of a strong work ethic. Yet some structural problems with the profession—its military[28] and corporate focus and the narrowness of engineering education, which excludes many important skills—can present obstacles when we engage in social justice work. In addition, there is an engineering outlook that privileges scientific knowledge over other kinds of knowledge, prefers certainty to uncertainty, and seeks single, simplistic explanations for complex social phenomena, which creates a political tendency that eschews social justice and presents real roadblocks in acquiring skills outside of engineering that are needed for social justice work. (Riley, 2008, p. 44)

Riley (2008) is clear to point out that this discourse does not equate to intentional, malicious, racial discrimination. Instead, she argues the problem is an inability to understand the structural aspects of racism (p. 80). Although there are clear instances of outright racial hostility in the engineering classroom (she provides an example here of a common electrical engineering mnemonic for the order of resistor color codes "Black Boys Rape Our Young Girls But Violet Gives Willingly") there is more indirect racial discrimination such as Eurocentric curriculum content, limiting ethnic stereotypes about

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some of which are described by Cech (2014), Goldberg, Somerville and Whitney (2014) and Riley (2008) as valuing technical over non-technical skills, undervaluing or lacking social competencies, and undervaluing or lacking the ability to critically examining social power structures.

[28] Riley (2008) is writing from an American context when she raises the 'military' dimension to engineering, which differs from the Canadian engineering context.

racialized students and their capacity for engineering[29], a lack of institutional support for racialized engineering students, and institutional cultures that reinforce social and economic class structures. These observations of racist attitudes and systemic racism within engineering education tally with research already discussed about racism on university campuses in general.

Riley argues that this systemic racism has a lasting effect on how racialized persons perceive their intellectual abilities and educational pathways, and can make it challenging for racialized groups who have been historically excluded from higher education and technological advancement to visualize themselves as an engineer, because that has not been an identity historically available to them or represented by others in their communities. This is not a novel argument, as research shows that popular representations of race can have a real effect on personal development among racialized peoples (Hall, 1989; Hall, 1997; Spencer, 2006).

In conclusion, the assumptions on ethnicity held by non-racialized domestic students and faculty, and the actions and systems these assumptions create and reinforce, continue to affect racialized international students, just as it does racialized faculty. The idea that racism does not exist if one's intentions are not racist still characterize university culture, despite the presence of statistical evidence and personal narratives to the contrary. Examining the institutionalized inequity of racialized students is therefore important,

[29] Ethnic stereotypes do not have to be negative to be damaging. For example, the 'model minority' stereotype applied to Asian Americans in the United States, assumes they have innate abilities that implies they do not need the assistance that other racialized peoples need, thereby ignoring the discrimination that exists and also criticizing other racialized groups against this model minority myth (Riley, 2008, p. 84).

because it highlights how little the academy has changed and the need for it to change if it is to be a productive, welcoming space for racialized students, faculty, and staff.

The following sections look at international students and their experience within Canadian universities. An important caveat to this discussion is that not all international students are racialized, as white American and Europeans are classified as international students in Canada.

2.7.3. International Students

The university experience of international students in Canada further demonstrates how racial discrimination remains a poignant problem at Canadian universities. This is an issue that is especially relevant given the aforementioned discussion of Canada's internationalization agenda, which will bring many more international students into Canadian universities[30]. Currently, the top countries of origin of international students at Canadian universities are China, France, the United States, India, Saudi Arabia, Iran, South Korea, Nigeria, Pakistan, and the United Kingdom (AUCC, 2014). Continuing to attract and retain these international students requires an honest assessment of their university experience to highlight any institutional problems that may hamper the growth of this important student demographic.

Much of the large-scale studies conducted on international student experience, outside Statistics Canada and other Government of Canada agencies, has been done by the Canadian Bureau for International Education (CBIE). However, the CBIE has a clear bias

[30] As of 2014, there were 67, 839 fulltime international undergraduates, 22,245 fulltime master's students, and 15, 075 doctoral students (Statistics Canada, n.d.), making up 13% of total university student enrolment in Canada. These numbers are expected to grow (Roslyn Kunin & Associates, Inc., 2012).

towards framing international student experience as positively as possible, given their goal to be a global leader in international education (CBIE, 2016a). Their research on international students is also not readily available, as despite being a non-profit organization that is committed to transparency, they charge $75 for their annual report on international education in Canada (CBIE, 2016b). Therefore, although their research is useful, it is not easily accessed, and it is potentially biased in favour of their organizational mandate. Furthermore, it appears that their Board of Directors is entirely white, with no visible minorities represented – despite the fact that 7 out of 10 of the top countries of origin of international students in Canada are Non-Western, and as such their citizens are typically racialized by Canadian society (Driedger & Reid, 2000). Clearly, this does not invalidate the CBIE and its research. However, it does indicate that its research alone may not capture the experience of international students who are racialized by their peers and teachers at Canadian universities.

The most recent, readily available publication of the CBIE's annual report on international students from 2009, demonstrates these concerns are valid. The research methodology is restricted to online surveying of international students, which does not allow for the in-depth feedback an interview can provide (Brewer, Torrisi-Steele, & Wang, 2015; Gopal, 2016). Surveys also do not easily build trust between the researcher and the participant, which is necessary for candid answers on sensitive social issues (Russell, 2005). Building trust with international students is especially important given their precarious residency status in Canada (Goldring, Berinstein, & Bernhard, 2009). Although a section of the survey questioned students about their experience entering

Canada, and their experiences on-campus and off-campus, those questions were straightforward and related to any financial problems, education problems, and general problems they had, and did not involve any discussion of racism they may have experienced, outside a single question on faculty sensitivity to racial issues. There was a section of the survey that directly queried their experience of racism, but it featured a single question “I have not experienced any form of racism or discrimination as an international student in Canada” and was assessed using a Likert scale of “Strongly agree – Strongly disagree”.

First off, the way the question is worded potentially skews the data, as it suggests to the survey participant that ‘not experiencing racism’ is the desired response. If the question had been worded affirmatively, “I have experienced racism”, the responses may have changed, as this wording indicates to the respondent that it is permissible to report being treated in a racist manner. Second, the use of a Likert scale to assess complex subjective experiences, such as being a target of racism, can only provide limited insight (Narli, 2010). Furthermore, when the data is broken down by region of origin, the reported statistic that 6 out of 10 students agree with this statement is less impressive. Students from European countries are most likely to agree with this statement, with an 8 out of 10 students agreeing or strongly agreeing, which makes sense given that the majority of students from European countries are likely to be fair-skinned, given the ethnic backgrounds of Europeans (Gibbons, 2015). Students from African countries, East Asian and Southeast Asian countries, South American countries, and the Caribbean are the least likely to agree with these statements, which is not surprising as they are more likely to be identified as visible minorities as they are less likely to be Caucasian, given their ethnic backgrounds (Association, 2015).

Therefore, large-scale studies of racialized students and their experiences with racism in Canada and its universities may not be overly helpful. Small-scale, in-depth qualitative studies are more appropriate to determining how racism operates in Canadian society and Canadian universities. It is not necessary to prove that racism exists; as previously discussed, institutional racism is a feature of Canadian society and its universities simply by looking at statistics on the education and labour market outcomes of visible minorities (Department of Canadian Heritage, 2005). What is necessary is understanding how it manifests itself, and its effect on racialized peoples. Unfortunately, there is limited research on racism among international students in Canada. Studies that are specific to the Canadian context are discussed below.

A recent study on international graduate students in Canada provided compelling data on the international student experience pulled from in-depth interviews with 10 students from East Asia, West Asia, South Asia, West Africa, South America, and Northwest Europe (Gopal, 2016). Students discussed the lack of inclusive practices within the classroom environment, with their peers and faculty both acting in manners that were exclusionary – they reported being singled out based on their cultural background, being subjected to racist stereotyping, being ignored by peers, or having faculty discredit their opinions. They also noted the lack of international perspectives and content within the curriculum and pedagogy, noting that the inability of faculty to broaden education beyond a North American context as a failure of the Canadian university system, and a way to preserve the dominant classroom discourse. They also discussed being discriminated against based on their language and accent, and feeling ignored or not being given the time to communicate. All of this culminates in their lack of peer interaction with domestic students, and feeling that it is the international students that need to take the initiative to befriend domestic students.

Another study, of South Asian Canadian students, reports similar concerns. The research also used a qualitative methodology, focus groups, with 7 student participants, to gain a nuanced and in-depth understanding of their experience of racial microaggressions. Eight themes emerged from their focus group discussion, which add further context to the data reported above on graduate international students. Participants reported (i) being perceived as 'fresh off the boat' and as such not fitting into Canadian society because they are too culturally oriented and/or lack English proficiency; (ii) being excluded from social life, because it is assumed they do not like to party and drink alcohol and are restricted from doing so by strict parents; (iii) feeling that 'being brown' is a liability; (iv) encountering assumptions that they are terrorists, or could be terrorists; (v) being expected to act as a cultural expert that can/should speak about their cultural; (vi) encountering assumptions that their intelligence is in stereotypical domains, such as sciences, engineering and mathematics (vii) the minimization of interethnic differences within, and ethnic differences beyond, South Asian Canadians; (viii) being ignored or overlooked by white Canadians (Poolokasingham, et al., 2014).

A qualitative study of four marginalized students in a Canadian university access program discussed how racism affects them in relation to the concept of merit, which was a prescient concern for them given their entry into university was facilitated by special programming for marginalized social groups. The access program, *Bridging the Solitudes*, runs out of York University and is intended to bring under-represented youth who experience barriers to entering important occupations and professions into university to gain qualifications. Program participants were required to meet the admission criteria for their chosen university program, so it was not a transition program. Instead, it helped students overcome the institutional, familial, social, cultural, and financial barriers that otherwise curbed their participation. Therefore, the concept of merit was important to them, because the researchers observed that they spent ". . . a considerable amount of energy trying to reconcile their experiences as students who were qualified for postsecondary education with the fact that they gained admission to university through an access program." (James & Taylor, 2008, p. 574).

Research from each student was collected over two years and included interviews, personal journal submissions, weekly focus groups, and their initial application materials to the program. Importantly, it was collected by researchers who shared an ethno-racial minority status, which helped build trust between the students and the researchers. The authors of the previous study on South Asian Canadians also explicitly noted their minority status as an important to their methodology and data collection (Poolokasingham, et al., 2014, p. 197). Although these students were not international students, they faced similar issues of discrimination. All of them were children of immigrants, identifying themselves either as Black African, Black Caribbean, or Central

American Hispanic. They also all came from working-class, single-mother families, which further disenfranchised them.

Their backgrounds were a compelling site of reflection on university education and the concept of merit, with the students discussing how meritocracy is a false assumption, because despite being equally qualified for entrance, and holding an equivalent qualification as their non-racialized peers, they negatively perceived their chances of success relative to their peers (James & Taylor, 2008). This perception is borne out by reality[31] (Department of Canadian Heritage, 2005; Samuel & Karam, 2000), and noted by the authors who comment, ". . .although some racialized and working-class students[32] attain postsecondary education, it does not alter the fact that educational institutions generally serve to reinforce and perpetuate the relative advantages of middle- and upper-class people, particularly those of European background." (James & Taylor, 2008, p. 570).

This research introduced another important window into the education experience of marginalized university students – be they domestic or international – as in its discussion of merit, it also discussed the importance of higher education for personal social mobility. This discourse is one that is not explicitly referenced by other studies of international students and their education experience, as a large portion of that research is concerned

[31] Compared to non-racialized persons living in poverty, racialized persons living in poverty are more likely to be highly educated, with 44% of racialized persons aged 25 to 64 years holding a university certificate, diploma or degree, compared to 25% of non-racialized persons. They also are more likely to be unemployed or receive less employment income – a median of $22, 400 compared to $27, 900 for non-racialized persons. Poverty in racialized communities is also a growing problem, particularly affecting recent immigrants despite their rising education levels. (Employment & Social Development Canada, 2009)

[32] The author would like to note her own working-class background has been a valuable standpoint from which she has conducted her research. Unfortunately, a separate discussion of barriers to access to university education for working-class persons is outside the scope of this literature review.

with a handful of topics. Gopal (2016) identifies the acculturation process of international students, their silence in the classroom, their self-segregation, and difficulties with group work, as the main topics interrogated by research on international students – all of which, she argues are portrayed through a deficit perspective, wherein students are blamed for their inability to overcome these obstacles, instead of the institution being examined for the barriers it creates to their inclusion, and the changes it could make to accommodate international students (pp. 22-24). Research that discusses the economic impact of university education for international students tends to look at the issue from a macro-level, concerning itself with how internationalization is a broad economic force. This discourse mainly discusses the advantages of internationalization to the host institution and country (which are predominantly Euro-American), with brief recognition that the exodus of educated youth from nations outside Europe and North America can be damaging to their countries of origin by depriving them of intelligent, highly skilled citizens (Guruz, 2011).

As to research specific to racialized international students in STEM disciplines, most of the available data is outside a Canadian context, and builds on the general discussion of institutional racism in universities: being isolated from peers and faculty (Le & Gardner, 2010; Mwangi, Peralta, Fries-Britt, & Daoud, 2016); a lack of representation in top STEM programs (Su, 2012), a lack of academic and financial support (Le & Gardner, 2010), a lack of employment and/or academic opportunities for racialized international students (Su, 2012); discrimination from peer and faculty based on their language abilities (Lee, 2007); questioning of their intelligence and abilities (Mwangi et al., 2016), and;

general ignorance about their cultural heritage and/or racist stereotyping based on their ethnicity (McGee & Martin, 2011), and the general whiteness of the university and the position of white privilege within it (Pilkington, 2013). Additional to this research is a relatively well-established body of knowledge on international engineering students.

Much of this research assumes a deficit perspective and/or does not engage with underlying issues of discrimination. Instead, the focus is on specific problems, such as English language acquisition (Lax, 2014; McGowan, Seton, & Cargill, 1996), acculturating international students to Western engineering education (Bennett, 2015; Cox & Diefes-Dux, 2006; Duff, Rogers, & Harris, 2006; Stewart, 2007) professional ethics (Austin, Gorsuch, Lawson, & Newberry, 2011; Newberry, Austin, Lawson, Gorsuch, & Darwin, 2011) and group work practices (Joyce & Hopkins, 2014; Maken, 2013). Very little research engages with engineering culture, exclusivity, and race. The lack of research specific to the international student experience of systemic racism in Canadian engineering programs or Canadian universities generally, as well as the limited research available on international students in STEM disciplines generally, is troubling given the continued negative effects racism has an already disadvantaged demographic. Again, this institutionalized inequity of international students highlights the lack of agency they experience within Euro-American universities, and the need for change in how they are treated by domestic students, faculty, and staff. The following section looks at the effects of racism on Indigenous university students, who are also typically racialized in Canadian society.

2.7.4. Indigenous Students

Given the large population of Indigenous peoples in Canada, and their long-standing experience of racism in Canadian history, and continued struggle against racism today, it is important to look specifically at discrimination against Indigenous peoples in Canada. Furthermore, although the above discussion of institutional racism is still applicable to Indigenous peoples, this section expands the discussion of discrimination based on ethnicity, to discrimination based on epistemology. Canadian universities operate through a Eurocentric epistemology that is founded on principles of empiricism, logic, and rationality (Fins, 2010) and Indigenous knowledges challenge these deeply held assumptions about how we know. Therefore, it is not surprising that there is still a lack of representation of Indigenous peoples and thought in Canadian universities, or that our universities reinforce institutional racism that discriminates against Indigenous persons based on their ethnicity and cultural epistemology.

The continued lack of participation in university education among Indigenous peoples, and the discrediting of Indigenous knowledges, is a poignant example of how systemic racism in Canada continues to operate in its universities. There is limited statistical information available about Indigenous students and scholars at Canadian universities – especially within engineering – and almost of that which is available comes from the Canadian Census. Of the specialized surveys of education issues, such as the Canadian Undergraduate Student Survey and Canadian College Student Survey, very few identify Indigenous persons in keeping with the terminology used by the Census, if they attempt to identify them at all. As one researcher into Indigenous education noted in 2006, "Of course, we can only obtain information about Aboriginal conditions from data that identifies Aboriginal persons, so the absence of this information means that most surveys used to provide data on educational issues are not useful with respect to Aboriginal Canadians. This, in itself, is an important observation." (Mendelson, 2006).

According to the Chiefs Assembly on Education, as of 2012, 1,172,785 persons in Canada identified as Aboriginal, and 698,025 identified as First Nations. Only 4% of First Nations people on reserve, and 8% in total, have a university degree, compared to 23% of the Canadian population (2012). Statistics Canada provides similar statistics, with 1,400,685 people identifying as Aboriginal, and 851,560 identifying as First Nations[33]. Of the 671,400 adults age 25 to 64 reporting an Aboriginal identity, 9.8% held a university degree, compared to 26.5% of non-Aboriginal persons in the same age range (Statistics Canada, 2011b, pp. 4-5). Younger Aboriginal women were more likely to hold a university degree than older Aboriginal women, and also more likely to hold a university degree in comparison to men. The proportion of Aboriginal women aged 35 to 44 who had a university degree in 2011 was 13.6%, compared with 10.2% of those aged 55 to 64. Among Aboriginal men, there was no difference with 7.6% for both men aged 35 to 44 and 55 to 64, holding university degrees (Statistics Canada, 2011b, p. 5).

Of the 389,200 persons aged 25 to 64 who identified as First Nations, only 8.7% had a university degree. The proportion of First Nations people with a postsecondary

[33] The term 'Aboriginal identity' refers to whether the person reported being an Aboriginal person, that is, First Nations (North American Indian), Métis or Inuk (Inuit) and/or being a Registered or Treaty Indian, (that is, registered under the Indian Act of Canada) and/or being a member of a First Nation or Indian band. An Indian band is defined as a body of Indians for whose collective use and benefit lands have been set apart or money is held by the Crown, or who have been declared to be a band for the purpose of the Indian Act. Many Indian bands have elected to call themselves a First Nation and have changed their band name to reflect this (Statistics Canada, 2016).

qualification was higher among those without registered Indian status (52.1%) than among those with registered Indian status (42.3%). The proportion of university graduates among First Nations people with registered Indian status was higher for those living off reserve than on reserve. Among the former, 10.9% had a university degree compared 4.7% for the latter (Statistics Canada, 2011b, p. 6). In terms of how these statistics play out nationally, Aboriginal people count for 4.3% of the total Canadian population, and First Nations people represent 60.8% of the total Aboriginal population and 2.6% of the total Canadian population. Métis represent 32.3% of the total Aboriginal population and 1.4% of the total Canadian population, and Inuit represent 4.2% of the total Aboriginal population and 0.2% of the total Canadian population.

Although Aboriginal peoples do not account for a large amount of the overall Canadian population, what is important to note is that their age demographics do not follow the trend among non-Aboriginals, as 6% of the total Aboriginal population were seniors aged 65 and over, less than half of the proportion of seniors in the non-Aboriginal population (14.2%). From a neoliberal perspective this is significant, because young Aboriginal peoples are a growing demographic that could add $401 billion to Canada's economy if they attained the 2001 education and labour market outcomes of non-Aboriginal Canadians by 2026 (Sharpe & Arsenault, 2010, p. 26). Much more importantly, however, research also shows that educational attainment among Indigenous persons in Canada has a direct impact on their quality of life – from better employment opportunities to healthier communities and personal well-being (Hull, 2005; Quinless, 2006).

Despite educational attainment levels trending upwards among young Aboriginals peoples, and the push by the federal government to support post-secondary attainment among Aboriginal youth with programs such as the Post-Secondary Student Support Program, University and College Entrance Preparation Program, Post-secondary Partnerships Program, Indspire (Government of Canada, 2016), and a variety of university-led programs that support Aboriginal students (Carleton, 2016; SFU, 2016; UBC, 2016; UC, 2016; UM, 2016), there are still incredible hurdles to overcome that start before Aboriginal children first enter the K-12 school system[34] (Friesen & Krauth, 2012).

Furthermore, Indigenous persons who do eventually enter the academy as students or scholars are discriminated against based on their ethnicity, as well as their cultural histories, literatures, languages, and knowledges, which are marginalized or completely erased as objects of legitimate study (Gallegos, 2005; Roy & Morgan, 2008). They too are blamed for their own disenfranchisement (Grande, 2007), and when they do access higher education they are expected to leave their culture and traditional knowledges behind for those of the academy (Bunda, 2012). Indigenous scholars therefore offer an additional insight into racism in the academy from an epistemological angle, not only a historical and cultural angle.

Indigenous knowledge arises from the long-term occupancy of a certain place. As a term, it refers to traditional norms and social values, as well as to mental constructs that guide, organize, and regulate how people live within and make sense of their world. It is

[34] Unfortunately, it is not within the scope of this thesis to discuss the multitude of barriers to educational attainment that Indigenous children in Canada experience. Resources on this topic are readily available at the Council of Ministers of Education, Canadian Teachers' Federation, Canadian School Boards Association, and the Canadian Education Association.

therefore the sum of the experience and knowledge of a given social group, and forms the basis of decision making in the face of challenges both familiar and unfamiliar (Hall, Dei, & Rosenberg, 2000). Die (2000) draws attention, however, to the fact the “the notion of 'Indigenousness' highlights the power dynamics embedded in the production, interrogation, validation, and dissemination of global knowledge. . .” (2000, p. 72).

Castellano (2000) comments when Indigenous knowledge is valued by mainstream society it is exoticized or misappropriated. Most often, however, it is not valued. She argues that Indigenous people are constantly told by non-Indigenous persons that what they know from their culture is worthless – even if that culture is romanticized and colonized by Euro-Americans. Castellano (2000) documents how the transmission of Indigenous knowledge has been disrupted by historical and ongoing Euro-American interventions because “. . . the process of knowledge creation - that is, the use of cultural resources to refine knowledge in the laboratory of daily living - has also been disrupted.” (p. 25). Indigenous youth no longer have daily access to experiential learning on the land; they have decreasing levels of fluency in Aboriginal languages that enable them to learn from elders; and they spend much of their time in educational institutions that discipline them to be dependent on the written word and communicate through Standard English (Roy & Morgan, 2008).

Due to these constraints, there is a real danger that the elders who still retain traditional and spiritual knowledge will join their ancestors without passing on what they know. Therefore, the dilemma for Indigenous educators, specifically in a Canadian context, is how to teach Indigenous knowledge when the traditional media for transmitting

Indigenous knowledge has become largely unavailable to many Indigenous people, and is not easily captured by text (Castellano, 2000; Coutrue, 2000). This is further compounded by the debate among Indigenous scholars about whether it is appropriate to record and/or transcribe the teaching of aboriginal elders (Kuokkanen, 2007; Hall, 2000), or if that will always fall short of the intended message (Coutrue, 2000) or even perpetuates neo-colonialism (McIsacc, 2000). When the voices of Indigenous persons are quoted at length by scholars, it often serves to highlight the romanticism and infantilizing of Indigenous persons (Harrison, 2004), for as bell hooks (1994) notes in her discussions of black vernacular, those who do not speak through the accepted cadences, phrasing, and vocabulary of Standard English are inherently judged by those who do as intellectually inferior.

Essentially, the experience of Indigenous persons and Indigenous epistemology in the academy makes visible the connection between political sovereignty with what Rouse (2006) calls epistemological sovereignty: “A sovereign power stands above and adjudicates conflicts among its subject powers, epistemic sovereignty is the standpoint above disputes among competing truth-claims . . . They are legitimated as truths by the precepts of rational method, the epistemic surrogate for law.” (p. 106). Therefore, “both knowing subjects and truths known are the product of relations of power and knowledge,” (Rouse, 2006, p. 107) and because the predominant epistemic sovereignty of this era is positivism, persons cannot be knowing subjects or speak truths unless they demonstrate the disciplinary knowledge of the positivist discourse (Kincheloe, 2008).

It is not all bleak, however, as positive strides are being made by Indigenous scholars and activists in the academy to change this epistemic sovereignty. In New Zealand – home to the Maori people – Maori academic and administrative staff are being supported through the strategic plans of New Zealand universities which “have employed a number of strategies specifically targeted at recruiting Maori into the organisation, increasing the potential talent from within the current student population, mentoring, supporting and progressing high performing students into roles within universities and strengthening the support around emerging and younger academics to accelerate career progression to more senior levels” (Pio, Tipuna, Rasheed, & Parker, 2014, p. 679). Therefore, while New Zealand universities are supporting the recruitment of students and academics and promoting their success, they are not requiring them to sacrifice their Indigenous knowledges or values to progress.

Bringing Indigenous knowledge into the academy not only benefits Indigenous people, but the entire university community, as Indigenous epistemologies are powerful counter hegemonic forces that can be a vehicle for responding to neoliberal university discourses (Kuokkanen, 2007). Indigenizing the academy, however, must be led by Indigenous students and scholars. If not, it lacks credibility, and may not identify or address important issues. However, their agency is curtailed from the get-go because their entire culture and epistemological heritage is often devalued by a Eurocentric academy. However, Canadian universities are beginning to look to Indigenous scholars to lead change and introducing new programs to bring Indigenous students into the academy[35]. This is especially needed in the STEM disciplines (Hermann, 2014). Whether this historic lack of Indigenous scholars is due in part to a lack of visibility, not simply enrollment figures, will be discussed in the data chapters, as this study found students do not always want to publicly identify themselves as Indigenous given the stigma that still surrounds First Nations, Inuit, and Aboriginal persons in Canada.

Finally, the institutionalized inequity experienced by Indigenous persons again highlights the need for change in Canadian universities and their treatment of racialized students, faculty, and staff. However, it goes further than that – it also demands Canada change its treatment of Indigenous persons in its entirety, so more Indigenous youth can be in a position to enroll in university and benefit from post-secondary study and accreditation. To do that, universities need to evaluate their Eurocentric pedagogical practices, and welcome and support Indigenous knowledges in their teaching and learning activities – promoting and nurturing the agency of Indigenous faculty and staff to lead such change.

2.7.5. Engineers, Education, and Equity: Concluding Thoughts

Examining the experience of women, racialized, international, and Indigenous students, provides a detailed picture of the lack of institutional equity certain people face in universities and/or the sciences and/or engineering education programs. Providing this information is important because it supports the characterization of engineering culture as

[35] The Truth and Reconciliation Committee has opened up a national discussion on Indigenous issues, and universities have taken up the call to respond to these issues, with many offering Indigenous study programs (UBC, UVIC, UA, UC ... this list is not exhaustive) or offering initiatives to promote Indigenous scholars, such as the University of Manitoba's Indigenous Scholars Fund which supports six Indigenous scholars or Queen's Pre-Doctoral Fellowship program that funds four Indigenous scholars who help Indigenize some of Queen's curriculum, and engage with local Indigenous peoples and communities.

an exclusionary space, and shows how it is not just engineering education that is exclusionary, but also university institutional culture broadly. Showing that this institutionalized inequity exists, and examining how it affects students, is crucial to understanding the barriers to change that occur in universities. The following section looks at how it is possible to build inclusive engineering through a specific peer-based learning model, curricular peer mentoring. The themes of pedagogy and change are predominant in this discussion.

2.8. Building Inclusive Engineering through Curricular Peer Mentoring

Systemic racism and heteronormative culture that can characterize STEM fields is not the only barrier to building inclusive engineering, but so too is the underlying epistemological grounding of engineering study and practice. Therefore, in order to build inclusive engineering, the assumption that engineers be white, Western, heterosexual males must be challenged as this discourages women and social minority groups from pursuing engineering education.

For example, Margolis, Fisher, and Miller (2000) discuss the damage of the ‘hacker boy’ stereotype female undergraduates in the computer science department at Carnegie Mellon University are presented with as the ideal computer science undergraduate student, but whom they do not identify with as they are often not single-mindedly focused on programming at all times. These social and cultural expectations discourage female computer science undergraduates who often lose interest in programming and leave their programs to take up other subjects that do not cause them to feel alienated (Margolis, Fisher, & Miller, 2000). A study on female Indian engineering students in the US shows the hardship Indian women face as engineering students who struggle with the expectations of patriarchal Indian norms to marry and raise children, while in the highly masculine organizational and cultural space of engineering (Dutta, 2016). Another study examines how social and cultural expectations can also set young women up for success or failure in math and science, arguing that the choices available to young African American women to pursue math, science, or engineering education is limited due to structural inequities in American society, and also discouraged due to cultural constraints within the black community that encourage or require black women to "display less power, self-confidence, competence, control, authority, and independence than [black] males." (Tucker, 2000, p. 143). In each of these articles, the authors bring to light the greater intricacies of gender dynamics, and how they can directly influence women and their choice to practice science.

Hynes (2000) and Subramaniam (2000), also speak to the challenges of being outsiders in Western science. They specifically highlight the dislike some white, Western scientists have about other cultures and peoples practicing 'objective' science. Hynes (2000) and Subramaniam (2000), contend objectivity in science largely reflects deeply embedded patriarchal ideas about the world. Therefore, when other cultures and peoples claim to conduct objective scientific studies, the discourse in which white, Western, heterosexual, male scientists hold power is threatened. Whitten & Burciaga (2000) show how these patriarchal ideals are perpetuated by the textbooks and other learning materials used to teach science, and Bartsch (2000) and Hughes (2000) raise concerns about the lack of interdisciplinarity within science, and the resultant danger of a science practice that is insulated from the larger social and cultural context in which it exists.

Hughes (2000) a geneticist by training tells the story of her own journey into science and how it was motivated by the desire to help others (a key characteristic identified by Miller, Rosser, Benigno, and Zieseniss (2000) in female science undergraduates) and how the disconnect between her science practice and her community focus led her to become a feminist as well. She eloquently communicates how imperative it is that science embrace alternative perspectives and participants in order to effectively negotiate the power science holds over fundamental questions about humankind when she offers the example of a question posed at conference on women and the Human Genome Project by a community participant who lives with achrondroplasia (dwarfism) about the future of people like her to exist, and the resultant silence she was met with by the scientists in the room (Hughes, 2000, p. 309). She also reflects on the pain with which a black woman spoke when discussing the impact that research on ‘violence genes’ might have on her community, saying of these experiences “In the end the participants, especially those from the scientific and medical communities, could not hear what those from the disabled and racialized communities had to say.” (p. 310).

There are, however, strategies to constructively respond to these realities. Suggestions include rewriting undergraduate STEM curriculum to be less biased in favour of white men and prejudiced against women and ethnicities (Phillips & Hausbeck, 2000), engaging students through non-traditional learning activities to communicate the larger social context in which science, math, and engineering is practiced (Barton & Osborne, 2000);

remodeling existing courses or introducing new courses for STEM majors that discuss the role of women and ethnicities in the sciences (Ainley, 2000; Hughes, 2000; Weasel, Honrado, & Bautista, 2000); and forging connections between STEM disciplines and arts disciplines (Bartsch, 2000) in recognition that "science students need to have a social context for considering the use of their science, and humanities students need to understand enough science to evaluate the meaning and implications of the science." (Hughes, p. 311). Until these changes happen, women or ethnicities will continue to face barriers to equality, as they do not reflect the "Supreme White Patriarch" that Subramaniam (2000), an Asian female scientist, depicts in her narrative account of studying and practicing in a STEM field as a woman and ethnic minority.

The following section posits curricular peer mentoring as a pedagogical vehicle for inclusive engineering education. A historical overview of curricular peer mentoring is offered, and an example of the model adapted for use in this study is described. The section ends by describing how this study attempted to utilize curricular peer mentoring to address the exclusionary culture of engineering education while operating in a neoliberal institutional context. Therefore, the theme of pedagogy is paramount throughout these sections, although the theme of change factors into the discussion because it is the goal of the pedagogy being examined.

2.8.1. Curricular Peer Mentoring: What it is

In this study, I argue that curricular peer mentoring can address these issues of institutionalized, deeply embedded inequities because it can be a vehicle for critical pedagogy and change within the university. As discussed previously, critical pedagogy interrogates notions of power and hierarchy in relation to education systems and educational content to expose structures that maintain social, economic, and political inequalities, within and beyond the classroom. It unsettles teachers as authorities in a learning hierarchy, and empowers students to take ownership of their own learning, which is why it may also be able to change university organizational structures and practices.

Applying a critical approach to STEM education, and as this study does – to engineering education – can be an effective method to changing the exclusionary culture of STEM education because it encourages students to reflect on discourses in the science and maths to become more aware of how those discourses empower some persons and some knowledges over others. When combined with curricular peer mentoring, this helps construct a self-determined learning community that can support students both academically and personally as they respond to the rigour of engineering education and its culture of exclusion. This critical curricular peer mentoring approach may also be construed broadly to university education generally, building the agency of those disempowered in the traditional university discourse and hierarchy, and changing how universities negotiate neoliberal constraints.

2.8.2. Curricular Peer Mentoring: A Historical Overview

Curricular peer mentoring programs are diverse, originating in the 1970s and the movement towards a constructivist education paradigm[36]. *Supplemental instruction (SI)*, which was developed at the University of Missouri Kansas City (UMKC) in 1973, is one of the first and most well-known curricular peer mentoring models (Smith, 2013). SI is

[36] See Smith (2013) for a detailed historical overview of curricular peer mentoring theory and programming.

used within any course that has high failure and attrition rates, as opposed to specific student populations. All students are encouraged to attend voluntary extracurricular study sessions run by SI leaders, wherein curriculum and exercises developed or co-developed by a target course's instructor are used (Smith, 2013). In addition to SI, other curricular peer mentoring strategies developed or used at the time were: (i) undergraduate teaching assistants (TAs); (ii) education through student interaction, which was a formalized student discussion group and possibly precursor to SI; and (iii) personalized systems of instruction, which used student peers to provide tutorials and assessments as part of a self-paced individual learning place (Goldschmid & Goldschmid, 1976).

SI continues to be a popular peer-based learning model: as of 2012 there were 228 United States institutions (in 44 states) with SI programs, 6 national centers (Australia, Canada, West Indies, South Africa, Sweden, and the United Kingdom), and 39 international programs (International Center for Supplemental Instruction, 2012). In Canada, there are 24 universities or colleges that utilize SI (Canadian SI, 2016), and SI has become a branded pedagogy, with specific program materials, training, and certification required that must be purchased to officially offer SI (UMKC, 2016) . SI is also closely associated with *peer-assisted learning* (PAL) which was founded in the UK. It similarly empowers students to run the program themselves, encourages collaborative group learning through trained student facilitators, and provides targeted support that is additional to course lectures and course learning objectives. It is different, however, from the SI model because it is not focused on high risk courses, emphasizes social integration and first-year team-building, and does not require SI leaders to attend all lectures and take notes in their designated course (BU, 2015).

Peer-Led Team Learning (PLTL) is a branded curricular peer mentoring program in the US, and was piloted at City College of New York in 1995. It is primarily used within the sciences and mathematics, and its program components include: faculty involvement, as it is not run through an academic support office; administrative support for the financial needs of the program; learning materials that are designed to fit the course and the workshop setting; organizational arrangements that facilitate groups of 6-8 students in 90-120 minute sessions; peer leaders are carefully selected and trained so they know the discipline and useful teaching and learning techniques; and, it must be integral to the course, so the program is set-up as a mandatory workshop series rather than drop-in sessions (Gosser, Kampmeier, & Varma-Nelson, 2010). It is estimated to be used in more than 100 post-secondary institutions, with more than 20,000 students, 150 professors, and 1,500 peer leaders engaged in official PLTL workshops annually (Gafney & Varma-Nelson, 2008, p. 1). Although it has demonstrated success in supporting student learning (Gosser, Kampmeier, & Varma-Nelson, 2010), it is a very costly, labour-intensive program which effects the ability of institutions to implement it, and its long-term sustainability (Gafney & Varma-Nelson, 2008).

Other curricular peer mentoring models include the use of undergraduate peers in First-Year Learning Communities (FYLC), writing fellows programs which assign writing tutors to course instructors and students, and various one-of-a-kind curricular peer mentoring programs that are unique to specific institutions and their teaching and learning context (Smith, 2013). These peer-based models are not necessarily curricular peer mentoring programs, however, as to be classified as such requires the specific intervention of student mentors in the academic work of their peers.

Smith (2013) defines the essential features of curricular peer mentoring as "…the undergraduate peer mentor's placement or attachment to a credit course and its instructor(s), his or her identity as a near-peer to students enrolled in that course, the wide variety of peer mentoring roles that may be instructional yet differ from authoritative instruction and grading, and the existence of a program that coordinates and supports the learning of peer mentors and their host instructors." (p. 27). She provides a nuanced discussion of what is meant by "peer", "mentor", "curricular", and "program" in order to provide a focused definition that characterizes this pedagogy against other peer-based learning pedagogies.

Curricular peer mentoring programs are varied, and as a pedagogical model they are flexible to specific institutional contexts. They can be used across disciplines, within various student populations, and in the pursuit of different learning objectives and goals. They can be a low-cost strategy that is scaled down for use in a limited setting; they can be well-funded program that is scaled up for department, faculty, or institution-wide application; it can be student-run or run through faculty and/or administrative units; and it can be purely instrumental, in that it works only to support student learning, or it can be a vehicle for the larger emancipatory objectives of critical pedagogy.

2.8.3. Curricular Peer Mentoring: An Example

Curricular peer mentoring, as used in this study, employed a service-learning approach wherein students served their peers (by assisting them with their learning) for an agreed number of hours over the duration of one academic semester. Alongside this practicum there ran a semester long course that the curricular peer mentors enrolled in for academic course credit that taught them about the practice of mentoring. The program modelled on the curricular peer mentoring program used at the University of Calgary (UC) and founded by Dr. Tania Smith.

The UC Arts Peer Mentoring Program was established in 2005 in the Department of Communication and Culture, now known as the Department of Communication, Media & Film. The program operates on a minimal budget that only requires paying for administrative support to perform record-keeping and data entry (not requiring a physical operating location), covering the hospitality costs of the annual introductory workshop for all peer mentors and host instructors, as well as covering costs related to the seminar course itself (Smith, 2008). With program growth from 8 mentors and 6 host instructors in Fall 2005 to 24 mentors and 12 host instructors in Fall 2011, and over 6000 students served in 36 courses at all levels of study across 15 disciplines/programs (Smith, 2012), the ability of the program to grow, adapt, and respond to institutional needs is proven. It is now established in the university's Nursing, Medicine, and Business faculties, and is beginning to expand into the Sciences (UofC Curricular Peer Mentoring Network, 2016).

The mentors are prepared for their work by enrolling in a senior-level seminar course that examines the philosophies and practices of teaching and learning, and which incorporates a service-learning component (a 40-hour practicum which is the time they spend mentoring in their host course) for course credit (Smith, 2008). Smith (2008) argues offering course credit instead of using an employment or volunteer-work model is more effective because students the mentoring practicum is tied to an academic course credit, so quitting jeopardizes the academic profile of the student. Given the type of student attracted and admitted to the program, this consequence is much more significant and severe than reneging on a volunteer commitment or losing a wage.

Additional to the mentoring seminar course is a weekly or bi-monthly meeting the mentor (or mentoring team) has with their host instructor to address any concerns arising from the class. Therefore, educators are also beneficiaries of this pedagogical approach as mentors can provide immediate feedback to the instructor on any challenges students face in relation to course work and lectures. Curricular peer mentors can also work with instructors to help foster learning communities that build relationships between students and with their instructors, to help support and engage students in their learning (Smith, 2007). Furthermore, the instructor is better able to offer their students the type of challenging coursework necessary for improving critical thinking skills and generally supporting student intellectual growth (conceptual thinking, literacy skills, communication skills) because they are not solely responsible for helping students in thinking and responding to course readings, or completing more demanding assignments.

Administrators and the institution generally, benefit from a program that is cost-effective to implement and run (Smith, 2008). Instruction costs associated with the seminar course can be embedded into the teaching responsibilities of a permanent faculty member, or covered by the tuition fees from the students enrolled in the course. There are many other ways to reduce costs until the program becomes more established with higher enrollment numbers to support more extensive administrative support: the program administration can be taken on by a faculty member in support of their university service requirements, or the program administration can be embedded into the responsibilities of another appropriate administrative body such as an office for instructional development.

2.8.4. Curricular Peer Mentoring as a Critical Pedagogy Practice in Engineering Education

As discussed throughout this chapter, universities are being affected by a neoliberal ethos that views public institutions as vehicles of economic activity that should and must ascribe to capitalist structures and conclusions. This neoliberal influence positions the university as a service provider and often ties the outcomes of a university education to the market, which can compromise the quality of university education.

Concurrently, however, universities are being affected by postmodernist theories of university education. Postmodernism challenges long held assumptions about the university and its activities, affecting the larger society in which the university exists. Traditional social hierarchies that privileged certain genders, ethnicities, and cultures over others have been called into question. It is no longer possible for the university to deny women, and/or people of colour, and/or Indigenous persons, access to a university education. Nor is it appropriate for certain university disciplines, such as engineering, to perpetuate a culture of exclusion against such persons.

Curricular peer mentoring, as practiced through a critical pedagogy approach, is a possible solution to both these issues, because it can support the diverse body of students in Canadian universities today, while also operating within their neoliberal organizational framework. By placing curricular peer mentoring in engineering undergraduate programs, it may even be possible to change engineering culture to be more inclusive – especially of women, racialized, international, and Indigenous students, who are often marginalized either in academia generally, or sciences, mathematics or engineering specifically. The goal of such an approach would be the empowerment of engineering students who might by disenfranchised by more traditional engineering discourses, and the encouragement of students already benefitting from such discourses to be aware of and responsive to the negative impact of these discourses on certain individuals and groups.

Curricular peer mentoring may also be transferable to other university disciplines, in pursuit of similar goals. The ability of the UofC curricular peer mentoring program to build a supportive learning community for students, and enrich their academic experience across academic disciplines, without a hefty price tag is a key reason why the program was adapted for use in this study. Although the program used in this study retained many core elements of the UofC curricular peer mentoring program, it differed by explicitly focusing on the issues of diversity and inclusion in Canadian universities and engineering undergraduate programs that were examined at length throughout this chapter. This focus on diversity issues was woven through course readings, assignments, and seminar discussion topics and questions[37].

[37] [37] Course documents are available in APPENDICES R, S, and T.

Similar to the UofC program, the curricular peer mentoring program piloted in the engineering faculty at Maple University incentivized students with course credit, utilized a service-learning model with a practicum component, and used similar assessment mechanisms as those used in the UofC program. It also enrolled the student mentors in a seminar course that provided them with the education and support to be effective peer mentors. However, the seminar course was not solely focused on teaching and learning theory, as it deliberately based itself in a critical pedagogical paradigm to address the experience of female, racialized, Indigenous, and international students. The seminar course therefore included course readings about classism, sexism, racism, along with topics directly relevant to engineering such as environmental sustainability, ethical reasoning, contemporary economic structures, and professional responsibility in relation to current engineering challenges and/or engineering activity. The intended learning outcomes for the mentors who enrolled in the course was the adoption of a more inclusive outlook about who can be an engineer, and an understanding of what sort of barriers women, racialized, Indigenous, and international students encounter in engineering education programs and subsequent professions.

Although critical pedagogy provided the axiological grounding of the pilot peer mentoring course, critical pedagogical theory was not directly instructed or discussed with the student mentors. Instead, the student mentors engaged with the aims of critical pedagogy through a critical reflective practice that was embedded into the course assignments[38] and course discussion. The critical reflection the curricular peer mentors engaged in was based on the work of prominent adult educational scholar, Stephen Brookfield (1995; 2006) who argues that students and teachers must reflect individually and collectively on their own paradigmatic, prescriptive, and casual assumptions to develop critical awareness about themselves as individuals, and learners and educators, but also as actors within larger social structures and hierarchies. Definitions of these assumptions and their applicability to engineering education are as follows (1995, p. 140):

- Brookfield defines *paradigmatic assumptions* as the basic axiological structure a person applies to their world. People often insist their assumptions are objectively valid renderings of reality. Critically examining these assumptions is difficult and is often met by significant resistance; however, changing them can have powerful repercussions. For engineers, this means realizing the limitations of post-positivist epistemology, and not passively accepting engineering cultures or practices that reinforce social hierarchies or activities that disenfranchise certain people or have negative social or environmental effects.
- *Prescriptive assumptions* are the assumptions a person makes about what ought to be happening in a particular situation. They are usually grounded in, or extensions of, paradigmatic assumptions. For engineers, this means evaluating the ideas that

[38] Course assignment descriptions and grading rubrics are available in APPENDIX T. These demonstrate the critical questioning employed in the course, and how that was used to build links between course texts interrogating engineering practices, course texts examining diversity issues and the mentoring practicum experience. These links were made to allow each mentor to reflect on their personal assumptions about engineering, diversity, and leadership. The mentors were specifically asked to examine how their assumptions have shaped them as engineers and leaders, and through their reflective practice change those that were inaccurate.

pervade engineering culture to better make decisions professionally and personally.

- *Causal assumptions* are the assumptions are the easiest to identify though critical reflection, because they are simplistic understandings of how different parts of the world work and the conditions that enable certain processes. In the curricular peer mentoring program studied in this research project, interrogating causal assumptions was the entry point used in the seminar course to lead the curricular peer mentors to deeper reflections on their prescriptive and paradigmatic assumptions.

The type of reflective practice that Brookfield is advocating, and which was used in the curricular peer mentoring seminar course, is radical because it based on the premise that ". . . every educational system incorporates biases which reflect the views and interests of those in possession of social, economic, and political power . . ." (Nesbit, 2005, p. 175). This radical practice harkens back to Freire (1970) who states "For the anti-dialogical banking educator, the question of content simply concerns the program about which he will discourse to his students; and he answers his own question, by organizing his own program. For the dialogical, problem-posing teacher-student, the program content of education is neither a gift nor an imposition – bits of information to be deposited in the students – but rather the organized, systematized, and developed "re-presentation" to individual of the things about which they want to know more." (p. 82).

Curricular peer mentoring, thus facilitates critical reflection because it empowers students to apply their learning within their communities, necessitating they reflect on and understand what they have learned so they can communicate it to others. This becomes a critical process when students are encouraged to take ownership of their own learning, because then they are choosing for themselves what is important and why it is important. Students are empowered and able to take ownership of their learning through curricular peer mentoring that uses a service-learning approach, as this directly involves student mentors in teaching and reflecting on academic materials and content, and questioning their usefulness and impact in mentoring their peers.

In this study, the intervention was aimed primarily at the learning and development of the mentors, by using the seminar course to develop their understanding and awareness of the different engineering discourses within engineering education and the profession, and the effects of discourses that are exclusionary, narrowly focused on technical goals, and unconcerned with larger social and ethical questions. Although the mentors were not specifically meant to counsel mentees who might experience offensive attitudes and/or exclusionary practices, they were made aware of what these attitudes might be, why they might exist, and be able to respond if mentees sought them out to discuss them.

The intention of this study was to raise awareness among the mentors about the issues with certain discourses in engineering education culture and the engineering profession. Ideally, they would then educate the host instructors and mentees about these discursive issues through their mentoring practice. As curricular peer mentoring allows mentors to be self-directed in identifying relevant discursive issues, respond to them as they work alongside their mentoring peers and interact with their mentees and host instructors, it may also be a pedagogy for change that empowers all students to be successful in university studies generally, and engineering undergraduate programs specifically.

2.9. Chapter Summary

The first section of this chapter, *The Postmodern University*, discussed the contemporary university, and the tensions of navigating the expectations of a postmodern society while responding to neoliberal institutional outcomes. An argument was made about utilizing pedagogy as way to ameliorate these tensions. The discussion then narrowed its focus to the impact postmodernist ideas have had on what constitutes knowledge, which has affected university pedagogy. It argued that traditional power structures within the institution have been disrupted, benefitting the university and challenging its established institutional and pedagogical practices.

The second section of this chapter, *Neoliberalism & The Postmodern University*, provided a detailed overview of the present-day reality of Canadian universities. The current state of Euro-American university education provision was reviewed, with an emphasis on the contentious university employment strategy of hiring contractual teaching staff over tenure-track faculty. This was followed be a review of the internationalization taking place at Canadian universities, which is being pushed for by the Canadian government. This lead into a discussion of the general loss of autonomy that Canadian universities are experiencing as they continue to be pressured by provincial and federal government bodies. The section ends with a discussion of the commercialization of the university, especially as it relates to its research activities.

The third section of this chapter, *Change and the Postmodern University*, was short, providing a brief overview of change management theory applicable to university institutional environments. This concluded with a discussion of how change can be facilitated in an oft resistant, or passively resistant, academic culture. The fourth section of this chapter, *Pedagogy for Change*, made an argument about pedagogies that promote change, whereby critical pedagogy becomes a vehicle for change. It narrowed the application of critical pedagogy to undergraduate engineering education, as the case study implemented in this research project was situated in a university engineering faculty. A comprehensive review of engineering education in general was then provided, and the section ended with an argument for establishing a 'critical engineering education' given the great power engineers wield.

The fifth section of this chapter, *Engineers, Education, and Equity* expanded on the discussion introduced in the previous section, and looked at systemic issues with inclusivity in engineering education and the profession as a whole. This discussion was broken down by specific sub-groups, looking at the experience of women, persons of colour, international students, and Indigenous students, in engineering education (or in STEM disciplines or the academy in general, where engineering-specific literature is scarce). The sixth section of this chapter, *Building Inclusive Engineering through Curricular Peer Mentoring*, introduced curricular peer mentoring as a pedagogy for change, providing a historical overview and examples. This was followed by a discussion about how curricular peer mentoring can foster change, linking it to critical pedagogy and its capacity to build inclusive learning environments. Finally, the chapter concluded by synthesizing these topics, bringing pedagogies for change to bear as the postmodern university responds to neoliberal influences.

In summary, how universities respond to the changing circumstances they face over these coming years is important as their success depends on their adaptability. They must adapt in the face of many entrenched notions about what the university is, and as the impact of neoliberalism encourages societal and institutional sentiments that mistakenly emphasize technical skill over conceptual abilities, and reconstitute universities as commercial enterprises. Although curricular peer mentoring cannot address all the issues that neoliberalism creates, it is one method that may help maintain a high quality of academic study during a time of upheaval within Canadian universities – and possibly introduce a critical change in how university education is structured in the contemporary postmodern paradigm.

Furthermore, incorporating critical pedagogy into curricular peer mentoring may also help students realize the larger effects of neoliberalism on their education and their future careers, as critical pedagogy exposes education as the 'great regulator', not the 'great equalizer', that ensures that power and wealth will remain concentrated (mostly) in the hands of those who already have it (Kress, 2011a). It reveals underlying struggles over epistemology by illustrating how throughout history, some people's knowledge 'counts' while others' is tossed into the epistemological trash heap of society" (Kress, 2011b, p. 286). This privileging of some types of knowledge over other types, as well as certain learners over others, positions engineering students to wield great social, political, and economic power, given how advanced technologies are totally entwined in all aspects of modern society. Therefore, it is important for engineering education to effectively engage engineering students in critical reflection about how engineering affects the world. Thus, this study is not only interested in how curricular peer mentoring can be a pedagogy for change, but also how it can strengthen the individual agency of university students, and the agency of university institutions.

CHAPTER 3: Methodology

3.1. Introduction

This study examined the ability of curricular peer mentoring to effect institutional change within Canadian universities that realizes postmodern ideals of social inclusion and equity despite the constraints of neoliberalism. To do this, a curricular peer mentoring pilot program and seminar course was implemented in an engineering undergraduate program to attempt introduce an inclusive and emancipatory pedagogy within engineering education.

The pilot curricular peer mentoring program was implemented in an engineering faculty at a medium-sized post-secondary research institution, Maple University, in Canada[39]. It combined a basic qualitative research design with a praxis-oriented case study method that examined curricular peer mentoring as a pedagogical intervention to meet specific educational goals defined by the engineering faculty. The effectiveness of curricular peer mentoring in meeting these goals was assessed, as was its ability to promote a 'critical engineering education' and to establish and extend institutional change more broadly.

The purpose of this research was therefore two-fold. First, to conduct an intervention: the application of curricular peer mentoring within a university academic program. Second, to investigate the efficacy of that intervention. The study therefore asked (i) could curricular peer mentoring be utilized as a critical pedagogical intervention to change the Faculty of Engineering teaching and learning practices, meet the needs of diverse

[39] Dates removed to protect participant anonymity.

students, and minimize the costs of student academic support? Furthermore, this study explored whether curricular peer mentoring could enact institutional change by addressing the needs and concerns of university education.

This chapter will provide a detailed overview of the qualitative research methodology designed to respond to these research questions. It will review the defining characteristics of qualitative studies, and the philosophical paradigm in which this qualitative study was founded. It will then discuss case study research design, as this was the type of qualitative design used. Following this description of case study design and a brief note about the data collection process, how the case study site was selected will be reviewed. From there, the research populations will be described, and the selection process rationalized. After this, the data collection methods will be discussed in full, broken down by method type and research populations affected. How the data was analyzed is described next, separated out into two distinct research phases as the nature of the study and the large amount of data collected required a two-part analysis process. This leads into a series of three short sections about the ethics, trustworthiness, and limitations of the study. Relevant to each of these three topics is the role of the researcher within the study. The chapter concludes with a chapter summary.

3.2. Research Paradigm

This was a qualitative study, which operated through an interpretive and critical paradigm to establish the research project, conduct the research program, and analyze the research data. Qualitative research is often exploratory, has an evolving methodology and explores participant's interpretations, perceptions, experiences of events or phenomena (Sherman

& Webb, 2004). The purpose of qualitative research is to understand how people involved in a specific phenomenon understand that phenomenon, and how they create meaning within that space and through their experience (Lauckner, Paterson, & Krupa, 2012; Merriam, 2009). Given the focus of my research was on micro-level change, it was important to capture individual responses to the curricular peer mentoring intervention. Therefore, a qualitative methodology was more appropriate than a quantitative methodology, as quantitative methods would be better suited to macro-level change management research studies.

As this study was concerned with how people interpreted their experience within a specific setting, being a university faculty, people's experiences and understandings of universities were brought to bear in the study. So too, however, was an exploration of power, and how it operates in university institutions, as well as through individuals and groups within universities, such as administrators, faculty, and students (Foucault, 1982). Therefore, this study was grounded in interpretive and critical philosophy to capture the individual experiences of the research participants, but also the larger institutional discourses that affected those experiences (Merriam, 2009).

Grounding this study in an interpretive paradigm was useful for analyzing the experiences of the research participants in the different research populations involved in this study. Interpretivism, also known as constructivism[40], holds that reality is socially constructed, and that there are multiple realities or interpretations of a single event (Merriam & Tisdell, 2016). There were numerous 'single events' within this study. First, there was

[40] Constructivism is discussed in *Chapter 1: Introduction*.

each host course classroom. In each of these classrooms, there was an instructor, a mentor, and students. Each of these three classroom participants would have their own interpretation of the host course, and the curricular peer mentoring intervention within that course. Another 'single event' was the curricular peer mentoring intervention construed broadly across the engineering faculty, and included the administrator, host instructors, mentors, and students, plus staff and faculty members not directly involved with the curricular peer mentoring intervention. Further 'single events' in question in this study were engineering education and university institutions in general, both of which are understood through a collection of interpretations from persons internal and external to the Maple University engineering program. Therefore, an interpretive research paradigm accurately captures the nature of the phenomenon being studied because there are multiple realities to be understood, and they relate to multiple events.

Grounding this study in a critical paradigm, however, was also important. Critical research has multiple theoretical approaches, some are Marxist and concerned with socio-economic order, some are concerned with epistemology, such as Habermas's notions of technical, practical, and emancipatory knowledge, and some are concerned with the socio-economic structures that support certain epistemologies, which are based in the Freirean notion of critical pedagogy (Habermas, 1971; Merriam & Tisdell, 2016). Critical research was useful for analyzing the theme of change, as change can be a socially, politically, and economically fraught process (McClaren & Kincheloe, 2007). It was also important to the themes of pedagogy, as in this study engineering pedagogy was interrogated through a critical pedagogical framework. Critical theory was also relevant to the examination of agency that administrators, faculty, staff, and students have within university hierarchies.

Therefore, a critical approach was also taken in this qualitative study, because the unique experiences of the various research participants were analyzed in respect to the historic power relations within universities, that have been socially constructed and reinforced through certain discourses that are ". . .powerful instruments for the reproduction of capitalist relations of production and the dominant legitimating ideologies of ruling groups" (Giroux, 2004, p. 192). Finally, in a general sense, a critical approach was appropriate because critical research seeks to bring about change, and causing change was the intention of the curricular peer mentoring intervention. The following section provides an overview of case study research design, and a rationale for why this qualitative research method was selected.

3.3. Research Design: Basic Qualitative Research and Praxis-Oriented Case Study Design

This research study is grounded in a basic qualitative research design, defined by Merriam (2009) as a general interpretive study that is interested in "(1) how people interpret their experiences, (2) how they construct their worlds, and (3) what meaning they attribute to their experiences. The overall purpose is to *understand* how people make sense of their lives and experiences." (Merriam, 2009, p. 24). She argues this is probably the most common form of qualitative research found in education, whereby

> Data are collected through interviews, observations, or document analysis. What questions are asked, what is observed, and what documents are deemed relevant

> will depend on the disciplinary theoretical framework of the study…The analysis of the data involved identifying recurring patterns that characterize the data. Findings *are* these recurring patterns or themes supported by the data from which they were derived. The overall interpretation will be the researcher's understanding of the participants' understanding of the phenomenon of interest. (Merriam, 2015, p. 25).

Embedded within this basic qualitative research design, is a qualitative case study. In qualitative case studies, the goal is to understand what is important in a case from an internal perspective (Evers & Loes van Staa, 2010). Therefore, the rationale for also using a case study design was to focus on a specific space to generate an in-depth and rich qualitative analysis of the curricular peer mentoring intervention through the perspective of the persons affected by the intervention. This case study was specific to the place, space, and time, in which the intervention happened, documenting the change process from start to finish. By examining how students, faculty, and administrators responded to the intervention, it was possible to explore the complexity of a change process through the perspective of various persons within the case study site (Lauckner, Paterson, & Krupa, 2012, p. 4).

This is a major strength of qualitative case study design, as it offers the opportunity to use many different sources of evidence (Freebody, 2003). Furthermore, a qualitative case study research design was specifically chosen because the curricular peer mentoring intervention was a micro-level change study, and gathering information specific to the time, place, and space in which this change process was attempted was the purpose of the research. Using a case study research design thus provided data from various research populations at various points during the curricular peer mentoring intervention that helped contextualize and deeply define the nature of university institutions, and the struggles encountered when trying to change them.

Multiple methods were used to collect and analyze the data. Again, this was intentional, as when “combining methods in the same study a researcher can partially overcome or counterbalance the deficiencies and biases that flow from single methodologies” (Evers & Loes van Staa, 2010). Such an approach is commonly referred to as *triangulation*. This study used multiple triangulation, as defined by Denzin (1989) to confirm the breadth and accuracy of the data set and its analysis. Of the four types of triangulation he outlines, this study used *data source triangulation, theory triangulation, and method triangulation. Investigator triangulation* was not used, however, as only one researcher was involved in the research project.

Data source triangulation is when data is gathered through several sampling strategies, at different moments in time, in different social situations (space), and with a variety or research populations (Denzin, 1989). This study made use of different sampling strategies, with various research populations, spanning different moments in time. A full description of the sampling strategy and research populations is given in the following sections. *Method triangulation* is when more than one method is used to gather data. This study used interviews, surveys, participant observations, and document analysis. Each of these methods is discussed in full in the subsequent section on data collection methods. *Theory triangulation* is when more than one theoretical position is used to collect and interpret data (Denzin, 1989). As discussed above, this study was based in interpretive and critical theories. Therefore, it also utilized a praxis-oriented case study research design within the basic qualitative research design and case study framework described already.

Praxis is the combining of theory and practice (Freire, 1970), which is what a case study is: a testing of theory within a practical setting. A praxis-oriented case study research design "…characterizes research that connects methodologies and theories with the political and practical concerns in the world. In other words, praxis lived out in case study research cannot avoid a critical, action-oriented stance aimed at challenging and changing societal injustices by emerging oneself in the tensions of emancipatory politics" (Nolan, 2010, p. 726). Therefore, the intention of praxis-oriented case studies differs from qualitative case study design, which is based in interpretivist research that is descriptive and does not seek to challenge or change status quo practices.

To truly employ a praxis-oriented case study requires building interactivity throughout the research process by including research participants in making meaning of the data (Lather, 1991). This was particularly important for the mentor and mentee research populations, as they were the two research populations structurally marginalized by the organizational hierarchy at Maple University. This reciprocal process was built into the research methods used with the student mentor and mentee research populations, which is described in the data collection methods section of this chapter. Therefore, theory triangulation was relevant to the underlying research paradigms informing this study, but also in the two, distinct case study research designs used because the case study was both interpretive and critical.

Furthermore, *data type triangulation* (Miles & Huberman, 1994) and *analysis triangulation* (Kimchi, Polivka, & Stevenson, 1991) were also employed to enhance the completeness of the findings and provide further depth and breadth to the study. Data type triangulation is when several types of data are used to understand the case, and are a result of the triangulation of data collection methods. In this study, interview transcripts, survey responses, official university statistics, were all used to analyze the data, as was completed student course work, email correspondences, and course documents associated with the curricular peer mentoring intervention. These data types are explained in the data analysis section of this chapter. Analysis triangulation is when several analytic techniques are used to validate the data set, which helps enhance the depth and breadth of the data analysis. It can include multiple units and levels of analysis.

Utilizing a qualitative case study research design not only ensured the comprehensiveness of the data collection, but also the accuracy of its analysis, given the use of multiple triangulation. Using a praxis case study design highlighted the importance of problematizing the case study setting and situating the collected data in a discussion of change. In general, using a case study research design was the appropriate choice for studying the research phenomenon, as case studies emphasize the uniqueness of an object of study (Hamilton & Corbett-Whittier, 2013). The main limitation of a case study design method is its lack of generalizability (Snyder, 2012), this is discussed further under the heading “Limitations” at the end of this chapter.

The following section briefly outlines the data collection process. An extensive explanation of each method is undertaken once the case study site is described, and the research populations identified.

3.4. The Data Collection Process

Data was collected in the form of (i) interviews; (ii) surveys; (iii) document analysis, and; (iv) observations. Interviews were conducted in a one-on-one or group interview format. Surveys were administered online and in-person, and featured fill-in-the-blank responses, yes-no questions, checkbox questions, Likert scale ratings, and open-ended questions. Both interview and survey data were collected at the close of the curricular peer mentoring intervention. Data was also collected from documents associated with the intervention. These included email correspondences, course documents, course assignments, and other miscellaneous course documents. Researcher observations were collected throughout the design and delivery of the curricular peer mentoring intervention. They were used to contextualize the other data collected, and feature throughout the data analysis.

These data collection methods are discussed in detail, after the following sections describing the case study site and identifying the research populations.

3.5. Selecting the Case Study Site

It was initially difficult to locate an academic department or faculty to host the curricular peer mentoring intervention. However, after speaking to numerous faculty leaders and academic committees, the Faculty of Engineering at Maple University informed me that they were interested in utilizing a peer-based learning program to address high attrition rates among first and second year students. The engineering faculty were also interested in exploring new ways to meet their professional accreditation requirements, which requires engineering graduates to be taught 'essential skills' as defined by the ECAB.

They were interested in implementing a curricular peer mentoring program to address these concerns. I hypothesized this could provide academic support to first-year engineering undergraduates within the classroom itself, while also preparing senior students for professional engineering through the seminar course. Senior engineering students could therefore learn the essential skills mandated in the engineering curriculum, such as leadership, communication, and collaboration, through a real-life scenario: critically reflecting on their engineering education in the seminar course and developing their leadership skills by mentoring their junior peers.

It was possible to implement the curricular peer mentoring intervention in the Faculty of Engineering because of its willingness to work around the bureaucratic and funding issues identified below. The faculty could provide funds to run the curricular peer mentoring seminar course and offer it as a ‘special topics course’ in the engineering academic calendar. The pilot curricular peer mentoring course was added as a senior undergraduate elective in the engineering calendar[41].

First, there were several barriers that had to be overcome before the curricular peer mentoring intervention could be implemented:

[41] Dates removed to protect participant anonymity.

(1) Bureaucracy

In general, different universities will have different calendar structures, and often this will be differentiated between departments and/or faculties. The calendar structure, and its relative flexibility, is vitally important to offering a new course, or any innovative academic course that seeks to issue academic credit. This requires a flexible university calendar that will accommodate the addition of an undergraduate course. At Maple University, there are no ‘general studies’ course designations available to list a new course that does not fall under the umbrella of a specific faculty, department, or course. Even special topics courses that are introduced to the calendar need to have a discipline specific course code. Therefore, adding a new stand-alone course or a special topics course was not possible unless it was tied to a specific academic course, and there was no premise or procedure for doing this within the normal operations of the calendar.

Over a period of two years I met with various administrators, and administrative bodies, to work around this roadblock. High-ranking officials, including the Deputy Vice-Provost Academic, the director of the administrative body responsible for teaching and learning initiatives across campus, the Dean of the Faculty of Arts, as well as the Dean of the Faculty of Science, all met with me. In addition to these meetings, a special committee of administrators, faculty, and staff who were proponents of novel teaching and learning initiatives was called. The result of these meetings was to locate an academic department that would have administrative support from the faculty, as well as personal support from faculty members, in which to register a course designated by a specific department calendar code and fund it from a specific department budget.

I presented the curricular peer mentoring intervention at various academic committee meetings to inform faculty members about the course and assess whether financial support was available within their specific departments to run the course, as well as whether there was a faculty member interested in hosting the course. Although there was a lot of general interest, the stringent requirements that would have to be met dissuaded any department or faculty member from agreeing to run the course. The main barriers encountered at this juncture were two-fold: how would the course fit into the existing departmental course structure and degree requirements, and; how would the course be funded by the existing departmental budget?

(2) Funding

The issue of funding was a primary concern throughout the process of setting up the pilot course. Although various departments were interested in running the course, the question of how to fund it was difficult to answer. Departments have a set budget, with only so many courses allocated to be taught on a per-course basis. This means any courses within the department degree course that were not instructed by full-time academic faculty had to be instructed by sessional instructors paid for each course they taught. Often, mandatory entry-level courses are taught by per-course instructors, meaning not only were funds scarce to pay an additional sessional instructor to run a new course, but to offer the new course might require cancelling a required course in that department and degree stream.

Therefore, unless the instruction of the pilot course could be tied to the teaching course load of a tenured faculty member, the department budget would have to cover the costs of paying a per-course instructor. This required locating a tenured faculty member interested in running the course, which proved difficult as often tenured faculty are already assigned to teach courses specific to their interests or senior level courses required by the department's degree schedule. Even if the research study could be placed in a department where the course could be added, funding that course was the next significant obstacle for me to overcome.

After two years of searching, I secured a faculty with which to run the pilot course: The Faculty of Engineering. The curricular peer mentoring intervention ran in three of its first-year engineering courses. The following section provides an overview of the research populations involved in the intervention, describing each in detail and outlining the participant selection, recruitment, and consent process. A rationale for why each research population was chosen is also provided.

3.6. Research Populations and Sampling Strategy

There were five stakeholder groups identified in the case study: mentees, mentors, host instructors, faculty and staff, and administrators. The mentors were senior undergraduate engineering students who chose to enrol in the curricular peer mentoring pilot program to act as mentors; the mentees were junior undergraduate engineering students in the courses where mentors were placed; faculty participants were those who acted as host instructors for the peer mentoring practicum; senior administrators were participants with direct involvement with the pilot course, and the staff consisted of non-academic faculty members and faculty at-large within the Faculty of Engineering. Participants from these stakeholder groups were recruited through the Faculty of Engineering webpage advertisements, faculty-wide email list-serv notifications, poster notifications, and in-class announcements delivered by the principal researcher and/or the instructor-of-record for the class.[42]

Each research population offers a unique perspective of the curricular peer mentoring intervention that factored into the research data returned. Therefore, the research populations are described in detail in the following sections because their roles and activities within the case study site influence their perceptions of the curricular peer mentoring intervention.

3.6.1. Mentees

All first-year engineering students are placed in an introductory program that uses a generalized engineering curriculum of introductory courses across STEM and humanities disciplines to prepare every student for their future engineering discipline. All courses are mandatory and are expected to be completed within three semesters (Fall, Winter, Spring). Of these courses, three courses were selected for the case study site as they were specific to the engineering faculty. These courses are referred to as ENGI A, ENGI B, and ENGI C to protect the anonymity of the research participants.

These courses are offered every semester, so students can choose how they schedule them, although there is a suggested planning sequence for students to follow as the math, physics, and chemistry courses build on one another and the advanced courses require meeting the introductory course prerequisites for entry. Students can also opt to take a work term over the spring/summer semester if they complete all required courses during

[42] Refer to APPENDICES H, I, J for Recruitment Notices

the Fall and Winter semesters. To be formally accepted into the engineering undergraduate program all students must successfully meet the requirements of the introductory curriculum.

It is important to note that to remain in the engineering program students admitted to junior engineering program must complete these requirements before the end of the academic year in which they are admitted. Students who fail to meet the requirements for promotion in this time frame are automatically withdrawn from the faculty. Furthermore, first-year engineering students must not only meet the academic requirements, but they must excel in their courses if they wish to enter a specific engineering discipline. At Maple University, there are five engineering disciplines that students can choose from if they meet the requirements for promotion. Meeting the minimum requirements only guarantees students a place in the engineering program; it does not guarantee they will be able to major in their chosen discipline. To enter a chosen discipline, the student must first apply for a position during the Winter semester.

Although students can make an application in advance of the deadline, many wait to make their choices as they still are completing courses that can impact their decisions (i.e. they are taking a course in programming and performing poorly and/or not enjoying it and therefore may not choose Computer Engineering given the importance of programming to that discipline). Even once a student puts forward the application, the faculty reserves the right to limit the number of spaces available in each major. First-year students who are top performers are the only students who can be unequivocally certain that they will be accepted into the engineering major of their choice, as all students are placed in a queue to select their top choice based on their grade average.

There were a total of 1,030 fulltime undergraduate students enrolled in the engineering faculty at Maple University during the academic year in which the pilot program ran. Of these, 26.1% were women and 10.6% were international students. This was 6.1% higher than the national average for female undergraduate student enrollment, but 5.2% less than the national average for international undergraduate student enrollment in Canadian engineering programs. There were 330 first-year engineering students, meaning they had not been formally promoted into the engineering faculty and a specific engineering discipline.

Mentees were selected on the basis that they were enrolled in one of the first-year engineering courses hosting the curricular peer mentoring intervention. The mentees were an important research population to study because their educational experience was a focal point of the case study research design, as the mentees were being directly affected by the practicum component of the pilot course. They were passive participants, however, in the sense that they simply existed in the case study site and were given no direction in terms of changing their actions, behaviours, or thought processes as students. Instead, their natural responses to the curricular peer mentoring intervention were assessed to see if it had indirectly affected changes in their actions, behaviours, or thought processes.

3.6.2. Mentors

There were three senior engineering undergraduate students that served as curricular peer mentors[43] by enrolling in the pilot course and mentoring their first-year engineering student peers in the three separate host courses in which they were placed. Mentors[44] self-selected to participate in the curricular peer mentoring intervention. Therefore, participant selection was not orchestrated by the researcher. Instead, participant recruitment was a result of three senior undergraduate engineering students choosing to enroll in the curricular peer mentoring seminar course. All three students were informed when applying to participate in the curricular peer mentoring pilot program, and again after they were accepted into the program, that the pilot program was part of a research project and by enrolling they were giving their implicit consent to be part of the research study. They were given the option to be active research participants by completing an interview at the end of the intervention. By enrolling in the seminar course, however, they consented to being participants as they were observed by the researcher in terms of the wider study surrounding the seminar course. Although recruitment of the mentors was not officially arranged, each mentor was representative of a specific engineering discipline, with female and male genders represented, as enrollees included two women and one man.

Their profiles are as follows:

- Claire: female, civil engineer, mentor for ENGI A

[43] Mentors are referred to using pseudonyms to protect their anonymity.
[44] Throughout the rest of the document, when speaking about the three senior undergraduate engineering students Katy, Cliff, and Claire, who served as curricular peer mentors for the curricular peer mentoring intervention, the term ‘mentor’ will be used interchangeably with ‘peer mentors’ or ‘curricular peer mentors’.

    - Claire holds a previous degree in the social sciences, and returned to school in her to pursue an engineering degree
- Katy: female, chemical/process engineering, mentor for ENGI B
- Cliff: male, mechanical engineer, mentor for ENGI C

The mentors were an important research population to study because they were the most active participants within the case study site. They were hosted by engineering professors (host instructors) assigned to teach the above courses (host courses). They were asked to define their role with the host instructors, then directly and consistently engage with the host courses by attending the classroom lectures, as well as any lab sessions or tutorials. They were also available for students to contact about academic and non-academic matters, both during and outside of classroom time.

The purpose for selecting the mentors was to capture their role as possible instruments of change within the curricular peer mentoring intervention. Understanding their experience offered further insight into the responses of the mentees who were the object of that intended change. It was also important to gain their perspective as senior engineering students on the engineering program and faculty, as they could provide an intimate knowledge of the entire program as a direct participant within it, which also informed the larger questions surrounding the case study site on institutional change.

3.6.3. Host Instructors

There were four host instructors who instructed the three junior undergraduate engineering courses that served as host courses for the pilot program intervention[45]. Two members of the host instructional team taught one host course. Instructors 1 and 4 taught ENGI C; they were paired with Cliff. Instructor 2 taught ENGI A and was paired with Claire. Instructor 3 taught ENGI B and was paired with Katy. Instructors are ranked 1 to 4 based on their academic rank, with 1 being high-ranking and 4 being low-ranking.

Like the mentors, the selection process for the host instructor research population was a result of their participation in the curricular peer mentoring intervention. As the instructors of record for the three first-year engineering courses hosting the peer mentoring practicum component of the intervention, they were naturally selected as research participants. They were informed before the intervention began, and again at the start of the intervention, that it was part of a research project. They were formally invited to participate in the research by giving interviews when the intervention concluded. The host instructors were recruited via email and in-person communication.

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[45] To preserve the anonymity of the host instructors, I will deliberately keep any further profile information vague. However, the correlation between ethnicity and status within the institutional culture of higher education is widely studied, and institutional racism within the academy is a reality (Eisenkraft, 2010; Colin & Lund, 2010; Pilkington, 2013; Henry & Tator, 2012). Arguably, there was evidence of racial discrimination within the host instructor population, as the racialized faculty member held the lowest academic rank despite the length of his teaching tenure. Gender discrimination was not directly observable within the host instructor research population, as all participants were male, but evidence of gender discrimination within the engineering faculty population was still present. Women made up less than 15% of the fulltime faculty members, and were predominantly grouped in lower ranking and/or contractual teaching staff positions. Again, discrimination towards women in the sciences is a well-studied (Eddy, Brownell, & Wenderoth, 2014; Reuben, Sapienzab, & Zingales, 2014; Settles, 2006; Shen, 2013; Williams, 2015).

The host instructors were selected to gather data on institutional change, and how people respond to change. Importantly, they were included in the research to offer insight into the hierarchical nature of university institutions and the biases universities operate through. This type of information was invaluable to characterizing the case study site, as well as informing the data obtained from the mentee and mentor research populations.

3.6.4. Faculty and Staff

The faculty and staff were an ancillary research population, which included all full-time tenured and tenure stream faculty, contractual faculty, and staff members within the engineering faculty. The faculty members included faculty across all engineering departments. Staff members included those who had academic support positions, such as lab technicians and course development specialists, but also generalized staff positions such as administrative personnel, co-op term coordinators, fundraising personnel and other roles not directly involved in education provision.

Faculty and staff were recruited via an email request sent out via the engineering faculty email list-serv. This email was sent out on behalf of the researcher by the administrative assistant working for the senior administrator, Professor Jackson, who had been the primary point of contact during the set-up and running of the intervention.

These staff members, and faculty not directly connected to the curricular peer mentoring intervention, were an important research population because they provided information about the impact of the intervention outside those it immediately involved. This information was useful because it characterized the organizational culture in the engineering faculty. It also was important for assessing the intervention as a vehicle for institutional change.

3.6.5. Senior Administrators

I liaised exclusively with one senior administrator, Professor Jackson, who was a key facilitator in introducing the curricular peer mentoring intervention into the engineering faculty. I had numerous online communications and in-person meetings with this administrator, prior to, during, and following the curricular peer mentoring intervention. He was recruited in-person, and verbally consented to be a part of the research study at the start of my interactions with him. At the end of the curricular peer mentoring intervention he was also recruited via email to participate in a formal interview, whereupon he provided his written consent for me to include our email correspondences and meeting notes, in addition to his interview responses, in my data set. Professor Jackson was a key data source because he provided an intimate perspective on the institutional culture with the engineering faculty, the historical and present attempts at institutional change, and the engineering program itself.

3.6.6. Summary: Research Populations & Sampling Strategy

The above discussion of the research populations and sampling strategy identified the key groups within the curricular peer mentoring intervention and provided a rationale for why they were selected to participate in the research. The following section outlines the methods that were used to collect data from each of these research populations. The data collection methods used were diverse, and some research populations were affected by multiple collection methods.

3.7. Data Collection: Methods

The data collection methods used in this study were: (i) interviews; (ii) surveys; (iii) observations; and, (iv) document analysis. Individual interviews and group interviews were used to assess patterns, outcomes, and experiences arising from the interactions between mentors and host instructors. An interview was also conducted with the key senior administrator directly involved in the curricular peer mentoring pilot program to get a high-level overview of the institutional culture and reception to change in the engineering faculty. Informal interview methods were also used specifically with the key senior administrator before, during, and after setting up the pilot program.

Students were surveyed about their response (both personal and/or academic) to the peer mentoring experience using paper-based questionnaires. Faculty and staff not directly involved with the pilot program were also surveyed using an online questionnaire to assess their awareness of the program intervention and determine whether it had any impact within the engineering faculty.

Furthermore, documents collected from the mentors, such as their initial applications to the pilot program, and the work they returned during the seminar course were, as well as email communications from the senior administrator and miscellaneous course documents were analyzed. Each document was analyzed for a specific purpose, with some document analysis being related to the theme of pedagogy, and others to the themes of change or agency.

Finally, researcher observations were compiled through all stages of the intervention: from setting up the pilot program and seminar, to the administration of the practicum component and seminar course activities. As the researcher, I was also a participant-observer of the curricular peer mentoring intervention. Therefore, my observations as a participant in the curricular peer mentoring intervention are interwoven throughout the analysis of data collected from the other methods used in this research study. They do not form a distinct data set, but instead my observations are used to better characterize data collected from the surveys, interviews, and document analysis.

My tripartite role as a researcher, and the program developer and administrator, is discussed under "Researcher Bias and Assumptions" at the end of this chapter. This discusses how the three standpoints (researcher, developer, administrator) I occupied in this study affected my research.

Below is a list of each type of data collection method used for each research population:

- Mentees: surveys
- Mentors: group interviews, researcher observations, document analysis
- Host Instructors: interviews, group interviews
- Faculty and Staff: surveys
- Administrator: interview, informal interviews, document analysis

Each of these data collection methods are discussed more fully in the following sections on interviews, surveys, observations, and document analysis.

3.7.1. Interviews

Individual and group interviews were used in this study because they provided rich, descriptive data on the curricular peer mentoring intervention. Interviews were conducted with the smaller research populations: mentors, host instructors, and the senior administrator. The mentors participated in a group interview instead of one-on-one interviews. This was a deliberate choice, as it allowed the mentors to respond to the interview questions in conversation with one another, and theoretically provide more nuanced and detailed responses. The host instructors were also asked to attend a group interview but given the option to participate in one-on-one interviews if preferred. Again, the rationale for the group interview was the possibility it would yield more data. The one-on-one interview option was offered in case one or more host instructors were not comfortable responding to the questions among their colleagues.

A similar interview script was used across research populations and interview formats, so data could be compared across each research population. Both the individual and group interviews were semi-structured, with question prompts and open-ended questions used to direct respondents. Open-ended questions were included in the interview guide, as they allow respondents to speak to topics more fully and/or introduce new topics of discussion. A semi-structured interview format was also used to allow a more natural, conversational dialogue with the interviewees to emerge (Maxwell, 2013), which helped build rapport with the interviewees and broadened the conversation (Merriam, 2009).

The literature suggests tape-recording semi-structured interviews due to the unwieldy nature of the discussion (Merriam, 2009); however, it also highlights the need to develop a rapport between the interviewer and interviewee (Creswell, 2015). Therefore, I chose to record notes by hand. I did not tape the interviews because as I was concerned that participants might speak less freely, or possibly decline the interview request or later retract their data, if they were being recorded. This concern was valid, as interviewees were at times being asked to directly critique their place of employment or academic study. Given the inability to provide complete and total anonymity to certain participants – particularly the host instructors – it seemed prudent to minimize any possibility that the host instructors, a key research population, would decline participating in the interview process or curtail their responses.

3.7.1.1. Mentors

The three student mentors enrolled in the pilot course elected to have a group interview, instead of individual interviews. This interview was held on the last day of the seminar, in an informal setting on campus. The interview was semi-structured, with a natural dialogue taking place between the three student mentors. The student mentors were asked about the seminar course, the practicum component of the course, as well as the overall engineering program.

Specifically, they were asked about what course readings, course content, and course assignments they found valuable, and what elements of this they would keep, lose, or add to a future version of the course. They were asked about their experience mentoring in the practicum component of the course, their relationship with their host instructor, and if the in-class practicum worked well or could be improved. They were asked about what they learned in terms of the course objectives concerning leadership development, teaching, and mentoring. Finally, they were asked if what, if any, impact the program had for them as senior engineering students and as future professional engineers.

Given the positive rapport the interviewer had with the interviewees, the rapport the interviewees had with each other, and that the group interview only had three participants, the conversation was very comprehensive. Topics of conversation were also introduced that were not in the interview script but were relevant to the purpose of the interview and added to the data set collected form the student mentors.

3.7.1.2. Host Instructors

I conducted individual interviews with one host instructor, Instructor 3, as well as a group interview with Instructors 1 and 4 who team taught ENGI C. The remaining host instructor, Instructor 2, chose not to participate in a meaningful way in the program and declined the opportunity to be interviewed at the end of the program. [46]

The interview questions featured similar questions to the student and faculty/staff survey, which interviewees first asked to state in what engineering department they belonged, they number of years they had spent teaching, the number of courses they were currently teaching, and how many hours a week they spent preparing for their course(s). All participants were also asked to estimate the time they spent each week in hours at work, volunteering, or caregiving.

They were then asked 12 open-ended questions about the pilot peer mentoring program, that queried their opinion about its effect on the engineering learning experience generally, the social and academic aspects of learning for the students in their courses,

[46] Whether Instructor 2 chose not to participate in a meaningful way may be due to the lack of agency he experienced in being part of the intervention, as his course was selected by the Key Administrator for the intervention. This was a significant limitation of the case study, as ideally host instructors voluntarily commit to the hosting a curricular peer mentor. That said, it also offers further insight into the challenges of introducing change within an institutional environment where power dynamics and competing interests affect personal agency of actors operating within all stages of the institutional hierarchy.

and its usefulness as a pedagogical tool. Host instructors were also asked if they would recommend peer mentors to their colleagues, if there were any courses they think would benefit from a peer mentor, and if having a peer mentor available to be assigned to a course would incentivize them to teach that course. They were also asked specifically about how they worked with and utilized the peer mentor assigned to their course.

3.7.1.3. Administrators

Professor Jackson, the senior administrator responsible for overseeing the pilot course was formally interviewed after the pilot course finished. This interview followed the same line of questioning and format as the interviews held with the host instructors. It was a semi-structured interview that investigated whether Professor Jackson thought the pilot program was valuable, met the concerns of the faculty – specifically its first-year introductory program, and whether the faculty was amendable or resistant to change.

Additionally, constant meetings were held between me and Professor Jackson prior to, during, and after the pilot course was offered, and he consented to have those informal interviews form part of the research data. An overview of informal interviews is given below, and how they were used and to what purpose are also reviewed.

3.7.1.4. Informal Interviews

Informal interviews are completely unstructured and typically used when a researcher does not know enough about a phenomenon to ask relevant questions and are instead exploring a situation (Merriam, 2009). My use of informal interviews was not strictly in keeping with this definition, however, because my objective was not explicitly to gain information. Instead, my objective was to administer the curricular peer mentoring intervention, and in pursuing that objective I received information relevant to my study through informal meetings and interactions. Although these informal meetings and interactions were similar in nature to formal interviewing methods, they lacked the defining criteria of asking questions or seeking information (Owen, 2014). Therefore, they were not strictly informal interviews. That said, these meetings and interactions were still unstructured communications with various research participants that provided useful research data.

This data collection method was used with the mentors and the key administrator. I consider the ongoing interactions I had with the mentors to be a series of informal interviews that took place throughout the duration of the curricular peer mentoring intervention. These interactions were mainly centered on our mutual participation in the curricular peer mentoring seminar course discussions and activities. The seminar course was a two-hour class, held weekly, that was structured as a graduate student forum wherein students prepared for the class by completing readings and then discussed those readings with each other, as facilitated by myself as the class instructor.

These interactions were an invaluable source of data, because they provided insight into the Maple University engineering faculty, and engineering education generally, from an insider perspective. The seminar also operated as a safe space for the mentors to critically evaluate the engineering faculty, and their engineering education. The seminar discussion topics often prompted this critical reflection, given the course readings and assignments were intended to involve the mentors in the praxis-oriented, critical research objectives of the case study. At the end of the term the mentors consented to releasing the observations and notes I made about our interactions, conversations, and activities, within the seminar course.

I had numerous in-person meetings and online communications with Professor Jackson, as he was my main point of contact within the engineering faculty and helped situate the curricular peer mentoring intervention in the first-year engineering program. We met before, during, and following the delivery of the pilot program. These meetings were a rich source of data, as Professor Jackson had an extensive knowledge of the faculty and its programs, and the strengths and weaknesses of those programs and the people operating within them. During these meetings, I would ask questions and pursue lines of discussion pertinent to setting up and running the pilot program, which naturally provided information about the engineering faculty relevant to the entire intervention. Professor Jackson consented to include our online and in-person communications as data, as he recognized the value of these communications in describing and informing the engineering faculty organizational culture, structure, and environment.

3.7.2. Surveys

Surveys are historically associated with quantitative research, and this remains a mainstream perception of survey research (Boeren, 2015). Surveys, however, are also a useful data collection method for qualitative research when they are designed to gather information about the characteristics, opinions, attitudes, or experiences of a population (Brewer, Torrisi-Steele, & Wang, 2015). Survey research is therefore very versatile and can be used to capture a large amount of data from many different types and sizes of populations. They typically do this by using a questionnaire that asks survey participants to respond to various questions, which can be asked in various formats (Boeren, 2015). Despite their wide-ranging scope, survey design methods are limited to a cross-sectional or a longitudinal design (Brewer, Torrisi-Steele, & Wang, 2015). This study used a cross-sectional survey design, with the survey only administered once to each research population sampled, using a questionnaire format and multiple question types.

Two surveys were designed and administered in this study. Surveys were administered online and in-person, and featured fill-in-the-blank responses, yes-no questions, checkbox questions, Likert scale ratings, and open-ended questions. Both surveys collected demographic data from respondents using a series of open-ended, checkbox, yes-no, and fill-in-the-blank questions. Both surveys then asked participants to respond to a questionnaire utilizing closed-questions that rated their knowledge of, and feelings towards, the curricular peer mentoring intervention using a Likert scale. An opportunity to provide further information through an open-ended survey response followed each closed-question.

Surveys were administered to the largest research populations: student mentees, and the engineering faculty and staff personnel. The student mentees received a paper copy of the survey, and faculty and staff personnel were invited to complete an online survey. They were sent to all students registered in the host courses, and all academic and non-academic staff in the engineering faculty. Therefore, the entirety of each research population was sampled.

Both surveys featured similar questions and were designed to have consistency to ensure I could collect comparable data from both groups. Some survey questions were also similar, and in some instances, verbatim to the interview questions asked of the host instructors. This was deliberately done to further build consistency across the different data sets. The student survey was an extended version of the faculty and staff survey, as it not only questioned respondents about their awareness of the pilot program and whether such programs were valuable, but also the experience the student mentees had as students in one (or more) of the host courses. The student survey therefore asked students about their academic performance within host courses, their expected grade in the host courses, their level of interaction with the mentors, and their opinion on the curricular peer mentoring intervention in general. Both surveys ended with a prompt to participate in further research about the curricular peer mentoring intervention.

The surveys were aligned with the praxis-oriented case study design (Willis, 2007) in that they offered open-ended questions throughout the survey to gather further comments or insights from the participants about the engineering faculty or engineering education. The intention behind asking these questions was to gather additional information about the faculty or program that could then be further examined with input from the respondents about the topics they identified as important. Unfortunately, neither the student or general staff and faculty respondents indicated a desire to participate further in the study, thus the critical research possibilities from these two research populations could not be explored.

The survey was valid and reliable because it was informed by another, established survey on curricular peer mentoring used at the University of Calgary. This ensured the applicability and performance of the questions, and the overall coherence of the survey design. It also opens an opportunity to compare my data set with data collected on curricular peer mentoring at the University of Calgary at a future point. The questionnaire scripts are available in APPENDICES K and L.

3.7.2.1. Mentees

Paper-copy surveys were administered to student participants in all three host courses. Of the 497 students registered across all three host courses, there were 176 survey respondents. Surveys were administered on the last day of class in each host course. The last day of class was chosen to (a) ensure the highest classroom attendance possible and (b) to provide as much time as possible for students to have interacted with the peer mentors. Response rates were determined by the number of surveys returned from all students available to be surveyed (i.e. registered) in each course, regardless of their attendance in class on the day of the survey distribution. These rates were: 60% in ENGI B, 41% in ENGI C and 6% in ENGI A. Administering the survey in ENGI A proved problematic as the host instructor: (i) gave incorrect instructions regarding who could complete the survey despite information given to the students by research assistant distributing the survey; (ii) did not provide class time for students to complete the survey.

The survey asked all participants to identify their gender, age, their major (or anticipated major), what year of their program they were in, how many courses they were currently enrolled in, and their estimated GPA. They were also asked to state what letter grade they expected to get in the host course, how many hours a week they spent preparing for their host course and whether that was more, equal, or less than the preparation they put into their other courses. Finally, they were asked to estimate the time they spent each week in terms of hours at work, volunteering, or caregiving.

Following this demographic section was a series of questions that required ‘yes’ or ‘no’ answers, and which provided information on if, when, and how often the students interacted with the mentors. Then students were asked to rate whether the peer mentoring intervention affected their social/personal, academic, or general learning experience using a Likert scale. Interspersed throughout these rating questions were open-ended questions which allowed students to add additional comments, as well as further ‘yes’ or ‘no’ answers about the peer-mentoring program and their interactions, perceptions and opinions of its efficacy.

At the close of the survey, participants were given the option to consent to provide their full names and their student ID numbers to access their academic records and/or further participate in the study. The survey could still be completed without consenting to reveal identifying information or further participation. Participants were not compensated for their participation. Unfortunately, only 31 students consented to releasing their academic records or further participate in the study, therefore student grade data for individual respondents was not obtained. Instead, an aggregate of the grade data for each host course was collected and compared to historical student performance data for each course. The collection of the aggregate host course grade data is discussed in the following section on *Documents* and analyzed in the data chapters.

3.7.2.2. Faculty and Staff

Participants were asked to provide their employment titles to determine whether they were a faculty member or a staff member. If they were a staff member, they were asked to state what area of the engineering faculty they worked. If they were a faculty member, they were asked to state in what engineering department they belonged. All participants were asked to estimate the time they spent each week in hours at work, volunteering, or caregiving. Faculty members were also asked about the years they spent teaching, the number of courses they were currently teaching, and how many hours a week they spent preparing for their course(s).

Following this demographic query, respondents were asked if they were aware of the peer mentoring intervention. Those who were aware of the program were asked about its value to engineering learning experience and what courses to which they thought it would be best suited. Those who were unaware of the program were asked general questions about whether they were aware of courses in the faculty that used non-traditional teaching approaches (examples of which were given in the questionnaire script[47]) and their opinion on such approaches to teaching.

At the close of the survey respondents were asked if they would like to participate further in the study, and consent to provide contact information, which was communicated as an option. The survey could still be completed without consenting to reveal identifying information. Participants were not compensated for their participation. The faculty and staff survey consent forms are available in APPENDICES A, B, C, and D.

3.7.3. Observational Data: Complete Participant Observation

Observational data is an integral aspect of social research and is a systematic and formal process of noting a phenomenon and recording it for research purposes (Angrosino, 2007). In this study, ethnographic observation was used because I was a researcher also

[47] See APPENDIX Q: Alternative Teaching Methods

involved with the object of study: the curricular peer mentoring observation. This type of observation is considered participant observation, of which there are many different variations.

At its most basic, “participant observation refers to a research approach in which the major activity is characterized by a prolonged period of contact with subjects in the place in which they normally spend their time. During the encounters, data, in the form of field notes, are unobtrusively and systematically collected.” (Bogdan, 1973). Its purpose is to develop an understanding of the complexity of social settings and relationships by viewing them holistically, which is achieved by immersing oneself in the research site (Bogdan & Biklin, 2007). Robert Bogdan (1973) is a foundational thinker in qualitative research and educational theory, and he notes that in carrying out participant observation, “The researcher would attempt to understand their world as they understand it, rather than as he or the outside world might imagine it to be. He would be interested in the perspectives of all the participants…He would enter the experience of his subjects by human and equalitarian method of sharing experiences with them.” (p. 303).

Participant observation can be overt or covert, and the participant can be an insider or an outsider (McCurdy & Uldam, 2014). The various positions along these two dimensions result in different types of participant observation: complete participant, participant as observer, observer as participant, complete observer (Tracy, 2012). Of these, this study used a complete participant method of observation. Complete participant observation is when the researcher is fully immersed in the research, and typically in a context in which the researcher is already a member. The advantage of this approach is the depth of observational data that can be collected, as “Being a complete participant allows insight into motivations, insider meanings, and implicit assumptions that guide actions but are rarely explained.” (Tracy, 2012, p. 107). Although I was a complete participant in the sense that I was an insider, my research role was overt.

As a complete participant observer, I collected observational data throughout the entirety of the curricular peer mentoring intervention. This data includes observations made of general university personnel, or specific engineering administrators and faculty who interacted with the intervention in any way, the mentors who enrolled in the pilot program and seminar course, the student mentees who were enrolled in the courses that hosted the curricular peer mentoring practicum, and the students who participated in a workshop led by the mentors.

Observational data collected on the mentors was the most formal set of observational data collected. This is because there was ample opportunity to make observations of the mentors as I met with them on a weekly basis for a two-hour seminar over the course of the academic term. These observations were formalized in individual profiles I made of each mentor, which are called “Leadership Profiles” and were embedded in the course assessment framework. These leadership profiles are fully explained in Chapter 4.

Observations made of other research participants, and the institutional environment in which the case study was situated, do not form a stand-alone data set, but instead observational data is discussed in the context of other data returned from the survey, interview, and document analysis data collection methods. This observational data is important, because it provides an insight into the curricular peer mentoring intervention from the sole participant responsible for every aspect of its development and administration. The observational data therefore better links the survey, interview, and document analysis data sets to one another, and provides further analysis of these data sets by situating each data set within a broader view of the curricular peer mentoring intervention.

3.7.4. Document Analysis

Document analysis is a systematic procedure for reviewing, evaluating, and analyzing documents (Bowen, 2009). Documents can be printed or electronic and include text and images. The form documents can take are varied, and can include: agendas, attendance registers, and minutes of meetings; manuals; background papers; books and brochures; diaries and journals; event programs (i.e., printed outlines); letters and memoranda; maps and charts; newspapers (clippings/articles); press releases; program proposals, application forms, and summaries; radio and television program scripts; organisational or institutional reports; survey data; and various public records (Bowen, 2009, pp. 27-28).

Like other qualitative research methods, the data yielded from document analysis provides in-depth, descriptive information about an object of study. Because documents are produced in social settings, they are social products that reflect a specific time, place, and space. Although they are ‘situated products, rather than fixed and stable things in the world’ they reflect a dynamic relationship of production, consumption, and content, of any given document (Owen, 2014). Therefore, document analysis is particularly useful in qualitative case studies because it produces rich data about the context of the research site, which can also be used to contextualize data collected through other methods

(Bowen, 2009). Additionally, documents provide supplementary research data that can be added to an existing knowledge base, and they can also be used to verify findings or corroborate evidence from other sources (Owen, 2014).

The advantages of document analysis are the objectivity of the documents themselves; they are empirical sources of information, not subject to researcher bias (Caulley, 1983). Even though they are still interpreted by the researcher, document analysis is often used in combination with other qualitative methods to lend credibility to that interpretation. Furthermore, as a method they are non-reactive and unobtrusive, meaning they are unaffected by the research process, which lends them further credibility (Bowen, 2009). They are also stable, as the researcher's presence does not alter what is being studied (Merriam, 2009). Their other advantages are their cost effectiveness, as they are often available at no or low costs. They are also widely available and an efficient method to use, as document analysis is about data selection, not data collection (Bowen, 2009). Finally, documents are exact, and they provide broad coverage, spanning longs pans of time, multiple events, and/or many settings (Caulley, 1983).

In this study, the documents analysed included: email correspondences between myself and various research participants; materials associated with the curricular peer mentoring intervention, such as the program advertisements, program application, and information session presentation; course materials associated with the curricular peer mentoring seminar, such as the course syllabus[48], course readings, and course assessments; coursework completed by the mentors enrolled in the seminar, such as their completed

[48] Course Syllabus is available in APPENDIX R.

personality tests, their reflective writing submissions, and their leadership philosophies; course statistics from each of the host courses in which the curricular peer mentoring intervention was set; and general statistics on the engineering faculty itself, such as the number of faculty, staff, and students, and demographic characteristics of each of these populations.

3.7.5. A Singular Data Method: The Mentors meet with the Key Administrator

To explicitly realize the objectives of a praxis case study design, there was a final data collection method incorporated into the research methodology. This was a meeting held at the end of term between the mentors and the key administrator, which I facilitated. I intentionally set a meeting between both parties, with the explicit objective of having the mentors speak to the administrator about their critical reflections on the education provision within the engineering program at Maple University. The meeting was an opportunity for the mentors to engage with the key administrator on topics arising from their journey as undergraduate engineers, with the mentors speaking to various programming and pedagogical issues they identified through their own critical evaluation of their education experience. This was a valuable methodological design, because it allowed the mentors to be active participants in the research process, giving them a platform to voice their concerns about their education experience in the engineering program at Maple University. Having them exercise their voice provided data not only on their experience with the program, but also observational data from the meeting itself as it was a vivid example of how making change is complicated by the organizational role a person holds in an institutional hierarchy. This is discussed further in Chapter 5.

3.7.6. Summary: Data Collection

The previous discussions of the sampling strategy and data collection methods outlines from whom data was collected, how that data was obtained, and for what purpose. The following sections describe how the data was analyzed. This data analysis is broken down into two separate phases in accordance with the two main pillars of the research program: establishing the curricular peer mentoring intervention, then assessing that intervention. There is a section dedicated to each research phase, with a detailed description of what constituted that research phase, what research populations were affected, and what data collection methods were utilized.

3.8. Data Analysis: Research Phases

Data was collected over two phases of study, and was analyzed using the constant comparison method of analysis to generate themes (Boeije, 2002), and narrative analysis to understand those themes and make the narratives of this case study explicit (Mills, Durepos, & Wiebe, 2010). The constant comparison method is an inductive method for analyzing qualitative data, whereby each segment of the data is first compared to one or more categories to determine its relevance and then compared with other segments of data similarly categorized (Fram, 2013). New analytic categories or new relationships between categories may be discovered as segments are compared, and their properties are identified and integrated (Schwandt, 2007). Through the constant comparison method, the themes of pedagogy, change, and agency were identified, and data from the first and second phase of the study was categorized using those themes, then compared to one another. Once these themes were identified, and data analyzed accordingly, deductive thematic narrative analysis was used to "fashion an abstracted chronology of events, character identities, and theoretic elements (themes, concepts, and perspectives)" (Mills, Durepos, & Wiebe, 2010, p. 592). However, given the critical nature of this study, the narrative analysis did not assume a monological framework. Instead, it asked how many narratives there were in the study, and how the narrative plot advanced by myself as a researcher matched those perceived by the other participants in this study (Reissman, 2004). The diagram below demonstrates how the goals, research participants,

and data collection are connected, with the entire research project broken down into

	Research Goals	Data Collection Activities	Participants
Phase 1: Intervention	Set-up pilot course Teach the peer mentors	Compile correspondences Collect course documents Observe mentors	Mentors Host Instructors Administrators
Phase II: Assessment	Understand the peer mentors and their experience of the pilot course and peer mentoring practicum Understand the student mentee experience of the peer mentorship intervention Investigate the efficacy of the pilot course intervention as a vehicle for institutional change within the case study site	Leadership profiles of mentors Survey student mentees Collect attrition and GPA rates on students in host course (before peer mentorship intervention and after) Interview mentors, host instructors, and key administrators about their experience of the peer mentorship intervention Survey of faculty staff (academic and non-academic) on peer mentorship intervention	Mentees Host Instructors Administrators Faculty, Staff

phases that have associated data activities and research participants.

Table 1: Research Phases, Research Goals, Data Collection Activities, Research Participants

The research program was comprised of two distinct research phases, with each phase encapsulating specific research activities and data to be collected from those research activities. The first phase was concerned with training the curricular peer mentors. The second phase was concerned with understanding the experience of the student mentees who were enrolled in courses hosting the curricular peer mentors and assessing the wider impact of the pilot course in affecting institutional change.

Each research phase featured research activities that were either aligned with the *intervention* – being the case study of the pilot course introduced in the engineering faculty – or with the *assessment* of that intervention. The collection of research data correlated to each research phase. With data being pulled from the pilot course itself, the courses in which the peer mentoring practicum was hosted, and interviews with faculty, administrators, and staff members either directly or indirectly involved in the pilot course.

3.9. Phase 1: Intervention

	Research Goals	Data Collection Activities
Phase 1: Intervention	• Set-up pilot course	• Compile correspondences • Collect course documents
	• Teach the peer mentors	• Observe the mentors • Collect course documents

Table 2: Phase I: Intervention Research Goals & Data Collection Activities

3.9.1 Set-up Pilot Course

The pilot course was set up over two academic terms. The turnaround on designing the course was quick because it could not be fully developed until it was determined in which faculty the pilot course would be run. It was important to know what disciplinary knowledge the senior undergraduate students enrolling in the course would have, to build on that knowledge base and link the pilot course material to their discipline area. Therefore, the course curriculum and resulting syllabus were chosen after securing the case study site in engineering.

Advertising the course to students took place throughout the period of course design, with the intention to have promotional materials sent out to students via faculty-wide list-servs and advertised on television screens used for sharing information placed throughout the engineering building. The advertising materials were designed and then approved by the research ethics board over the Summer term to have adverts distributed for Fall. Unfortunately, the engineering faculty delayed the distribution of the advertisements until late into the Fall term, which impacted the response-rate in terms of enrolment of senior undergraduate students in the pilot course.

All engineering students have a restrictive course schedule, with only limited course slots (generally known by university students as ‘options’) that can be freely chosen according to their interests. These limitations are compounded by the fact that only certain optional courses are permitted as choices for engineering students, and furthermore, optional courses can only be taken while students are not on a work-term. The entire undergraduate program consists of eight academic terms and four work terms. Within the eight academic terms all engineering students must complete a minimum of 21 credit hours, but there are even further restrictions – of these 21 credit hours, 15 credit hours (5 semester long courses) are chosen for the students. That leaves only 6 credit hours left, which is equivalent to 2 semester long courses. Therefore, there are only 2 courses in the entire 4-year program that are open to students to freely choose. As my course was a special topics course, it was considered one of these two optional courses.

Due to these significant restrictions on when and what courses students can enrol in throughout their engineering program, combined with the late advertisement of the pilot course, there was only 3 students who enrolled in the pilot course.[49] Enrolment had been anticipated at 10 – 15 students, which altered the structure of the practicum component of the course as each student was placed on their own in a host course, instead of there being student mentoring teams of two or more students placed in each host course. This in turn affected how the host course utilized its student peer mentors, and the amount and breadth of research data collected from each host course.

Once the course was set-up, and host courses and host instructors were identified, and the mentors were officially registered and admitted into the course, I hosted an introductory meeting for all the administrators, faculty, and teaching assistants involved in the program to explain the program to them and to introduce them to the senior engineering student mentors. This meeting took place at the beginning of the term, and helped orient all persons affected by the pilot course in terms of its purpose, ideal execution, and

[49] There are possibly other contributing factors to the low enrolment as well, such as a lack of interest, lack of perceived relevance, uncertainty about the value of the course, etc. Unfortunately, it was not possible to determine this inconclusively.

anticipated results. It also clearly communicated to all participants that the pilot peer mentoring program was part of a larger research study being conducted about change in universities.

Data Collection Activities

The relevant data associated with this research phase includes all course documents such as the course description, course advertisements, course syllabus, course application materials and application submissions, as well as all correspondence with administrators and faculty involved in setting up the pilot course.

3.9.2. Teaching the Mentors

The seminar course ran for one semester, with a book *The World in 2050: Four Forces Shaping Civilization's Northern Future* and 10 academic articles assigned to be read over the term. The book was a general interest non-fiction exploration of contemporary global issues that are threatening to become significant problems by 2050, according to the author Laurence Smith, who is a geographer and climate scientist at UCLA who outlined four 'forces' that are shaping civilization: population growth, natural resources, globalization, and climate change. The articles were pulled from academic journals and were primarily sourced from management literature and education literature and covered the following topics:

- Peer-based learning
- Problem-based learning
- Active learning
- Critical reflection
- Power & Leadership
- Effective leadership
- Sex & Sexism
- Difference & Discrimination
- Ethics & Pragmatism

One book chapter and one article were assigned per week (including over the two weeks that class was not held). Students first learned specifically about curricular peer mentoring – as that was the type of peer-based learning they were involved in – from an article that described its implementation, usage, and efficacy in an engineering faculty. A series of education articles built the senior student mentors' knowledge of education theory, so they could apply it when mentoring their junior student peers. The management articles discussed topics that dealt with professionalism – ethical behaviour, discrimination, power dynamics, and leadership. These articles were intended to build a knowledge base that was transferable to the engineering workplace, while still immediately serving the senior student mentors as they mentored their junior peers and engaged with their host course instructors.

The book was used to engage the senior engineering students with the academic articles, by asking them to think about the topics raised in the book in relation to the articles and their understanding of engineering as an activity and profession. If the pilot peer mentoring course had been run in a different faculty, the choice of book would likely have changed to be more reflective of that disciplinary knowledge and interests. The topics covered by the academic articles would still be suitable regardless of discipline.

Course assessments consisted of: submitting a semester plan that outlined their practicum responsibilities with their host instructor; leading a workshop for first-year engineering students; tackling a personal growth challenge; developing a leadership philosophy; critically reflecting on their mentoring practice; completing a practicum portfolio documenting their mentoring activities; and contributing to the seminar discussion. Students would meet weekly to discuss the chapter and the article assigned for the week, and question how the readings were connected to their mentoring practice or could be connected to their studies and work as an engineer. The discussion also acted as site for the senior students to mentor each other through any challenges or issues they encountered in their host courses.

Data Collection Activities

The relevant data associated with this research phase comprised the course syllabus, course schedule, course reading list and the readings themselves, all assignment outlines and grading rubrics, as well as all completed assignments.

3.10. Phase II: Assessment

	Research Goals	Data Collection Activities
Phase II: Assessment	• Understand the peer mentors and their experience of the pilot course and peer mentoring practicum • Understand the student mentee experience of the peer mentorship intervention • Investigate the efficacy of the pilot course intervention as a vehicle for institutional change within the case study site	• Interviews with mentors • Leadership profiles of mentors • Survey student mentees • Collect attrition and GPA rates on students in host course (before peer mentorship intervention and after) • Interview host instructors and key administrators about their experience of the peer mentorship intervention • Survey of faculty staff (academic and non-academic) on peer mentorship intervention

Table 3: Phase II: Assessment Research Goals & Data Collection Activities

3.10.2. Understanding the Mentor Experience

To understand, as best as possible, how the mentors experienced the pilot course and practicum, I continually observed the student mentors in the seminar course, as well as during the workshop they hosted for the first-year engineering students. Due to various constraints, I was unable to observe the mentors in their host courses. Although observing the mentors in their host courses would have been preferable, the observations I did conduct of the mentors in the seminar course and the one-time workshop they hosted for their junior peers were sufficient.

The seminar course proved to be a challenging environment in which to observe the mentors because I was also the instructor-of-record for the course, and a participant observer. Therefore, to compile observational data on the mentors, I outlined an agenda for each class that included relevant course readings, discussion topics, and important themes and questions. I also wrote brief notes during the class for each agenda item where relevant. The workshop the mentors hosted for their junior peers was a rich environment to observe the mentors, as the mentors had all responsibility for delivering the workshop which allowed me to focus solely on observing the mentors in action with the first-year engineering students.

Using the in-class and workshop observations, I compiled a leadership assessment of all three senior peer mentors outlining their weaknesses and strengths as leaders that was then presented to them during a midterm review session. The mentors were asked to read their profile over, evaluate it for its accuracy, and discuss the suggested ‘personal challenge’ I provided each mentor with to strengthen their leadership capacity. These leadership profiles were revisited at the end of term, with students commenting on their development from the midterm review. They were asked to reflect on the personal challenge they were asked to undertake, and discussed this in a written critical reflection and with each other in our last seminar session.

The last class of the term operated as a group interview, with all 3 mentors providing insight into what worked well in the course and what did not, what readings they would keep and would leave out, what assignments they would keep, leave, or alter, and their thoughts about the practicum component of the course. The group interview questions can be found in Appendix O. Mentors were also asked to comment on the effectiveness of the current engineering program and curriculum and provide suggested changes or highlight gaps in the curriculum.

Data Collection Activities

Data from this phase includes the observations of the mentors, their personal growth challenge, and their leadership philosophies. It also includes the workshop planning correspondence, the workshop materials, and the observational data gathered from the workshop itself. Other important data sources include the seminar discussion agendas and notes, as well as the end of term group interview.

3.10.3. Understanding the Mentee Experience

A survey distributed to mentees in all three host courses asking them about their mentorship experience. This was the primary way data about the mentee experience was collected. The survey, as described previously, was a comprehensive series of questions that aimed to provide a picture of each survey respondent in terms of who they were as a person, which was done to better characterize their attitude and response towards the peer mentoring intervention. Using questionnaires to build a picture of survey respondents is difficult, and it was therefore important to interpret the survey data from the students as accurately as possible. Without a good understanding of the student respondents, it would be hard to understand why they reacted to the peer mentoring intervention as they did.

Therefore, the survey asked a series of questions about the student in terms of their education history, academic and non-academic responsibilities, and basic personal information. This helped provide a profile of each respondent and inform why they may or may not have chosen to engage with the peer mentor assigned to their course. For example, a male engineer might be less inclined to interact with a peer mentor as he would have many male peers he could speak to if he had questions, whereas a female engineering might be more inclined to seek a peer mentor out as there are less women in the engineering program and research shows that women in the STEM disciplines often feel excluded from the comradery of their male peers (Eddy, Brownell, & Wenderoth, 2014). Or, if the peer mentor assigned to the host course was Claire, the female civil engineer, and there was a male engineering student who wanted to specialize in mechanical engineering but was struggling with his grades, he might choose not to seek out support from a female mentor, who also had chosen to specialize in a different field, as research shows we are more comfortable accessing support from people with whom we identify (James & Taylor, 2008).

The survey then asked another series of questions that attempted to gauge how much, if at all, each respondent had interacted with the peer mentor assigned to their course.

Questioning began by asking whether the student had been introduced to their peer mentor by the host instructor and how involved the peer mentor was during class. These questions were asked to gauge how the host instructor influenced the exposure the student had to their peer mentor. Questions were also asked about the amount of time, if any, that the student interacted with the mentor inside or outside the classroom to gauge how involved students were with their peer mentor. They were also asked about how accessible they found the peer mentor, to determine if students were unable to engage with the program due to the mentor being unavailable, as opposed to a lack of integration into the course by the host instructor or an unwillingness to participate on behalf of the students. Respondents were also able to answer a small number of open-ended questions if they had further comments to make on their level of engagement with their peer mentor.

Lastly, in terms of participation with the peer mentors, students were also asked about a specific presentation given by all three mentors. This question was asked to see if students were more likely to participate in one-off activities featuring their peer mentors, as opposed to ongoing interactions with the mentors. It should be noted the presentation featured an incentive for participation: free pizza.

Students were then asked to use a Likert scale to rate the effect of the peer mentors on the social/personal learning in the course, their academic learning, and their learning experience in general. They were also asked open-ended questions requesting feedback for the mentors and host instructors in terms of what was most beneficial, what advice or criticism they might have to offer, and what the instructor could do to more effectively utilize their peer mentor. Finally, they were asked if they knew about the program before taking the course, if they were taking any of the other two courses using peer mentors, and if they would choose a course because there was a peer mentor assigned to it, or if there were any courses with which they would like to have a peer mentor involved. Respondents were also invited to participate in future surveys or interviews, and consent to letting me access their academic records. Very few respondents chose to be contacted for future studies or consented to making their academic records accessible; therefore this data was not included in the research findings.

The comprehensive nature of this survey helped capture the mentee experience. Although interviews would have provided a more nuanced picture of that experience, given the fact that the total number of students available to participate in the study was just shy of 500, it was not feasible to conduct interviews. Of the 497 students registered across all three host courses, there were 176 survey respondents. This provided an impressive amount of data from the student mentee research sample, and given the qualitative nature of the survey they completed, it has provided a host of rich data to help inform the more quantitative aspects of some of the survey questions.

Attrition rate and, GPA scores were also collected in the courses hosting peer mentors to compare against previous GPA scores and attrition rates from the same courses in previous years. This enabled the learning environment to be characterized in terms of the course logistics: average number of students in the courses, average grade point of each cohort, grades achieved on mid-term assessments, etc. This helped provide a general overview of the learning environment the first-year engineering students entered, which helped inform the survey data collected from the student mentees.

Data Collection Activities

Data from this phase includes the student survey responses from all three host courses, as well as the host course and historical course GPA scores and attrition rates. It is, however, informed by the information the peer mentors provided during their group interview that directly relates to their observation and understanding of the student experience from their perspective as a mentor. This also includes the information the host instructors provided during their interviews that directly relates to their observation and understanding of the student experience from their perspective as an instructor. Furthermore, it includes my own observations of the students from the peer mentors' presentation to the students.

3.10.4. Investigating Institutional Change

There were two primary ways that institutional change was investigated: through interviews with host instructors and key administrators, and surveying academic and non-academic staff in the faculty. By analyzing the host instructor and key administrator response to the pilot program, data could be collected on the openness to change from those closely involved with the change intervention. Surveying the general faculty personnel provided insight into whether the faculty was aware any changes were taking place, and if they supported them, or disagreed with them, or were simply indifferent. For institutional change to take place, that change must be communicated effectively, and it must also be supported (Anderson, 2011), which was why these research populations were studied, as they are representative of all non-student stakeholders in a university faculty.

The host instructors provided a perspective on change within the engineering program from their position within the classroom and as arbiters of their respective course content. As they were all responsible for delivering the first-year engineering program courses, their understanding about if that program needed to be changed was directly informed by their teaching role. Their position as educators also informed their opinion into whether they saw a need for greater change beyond the first-year experience, and within the entire engineering program itself. Their position as engineering faculty was therefore relevant to their response to the intervention, and the greater change it was intending to cause. Thus, they were a key population to study to assess institutional change as they were significant stakeholders within any change process.

Professor Jackson, the senior administrator, was also interviewed for his perspective on change. This interview was informed as well by the many meetings held between Professor Jackson and I in setting up and administering the curricular peer mentoring intervention. Understanding the nature of change from a top-level perspective was important. Unlike faculty, who may have a vested interest in maintaining the status quo due to the interruption to their teaching style, teaching content, or teaching objectives, would cost them in terms of energy and time, high-level administrators are responsible for ensuring positive outcomes from faculty instruction methods, as well as delivering a relevant curriculum and overall degree program. This meant his perspective on change was important to capture because he was responsible (along with other high-level administrators) for the best functioning of the institution itself.

All engineering faculty personnel (academic and non-academic) not directly connected to the curricular peer mentoring intervention were surveyed about their knowledge of the pilot course. This helped flesh out the overall institutional awareness and knowledge of the intervention. By determining whether faculty personnel unconnected to the pilot program were aware or knowledgeable of the program, I could determine if the pre-pilot advertisements and preparations had even caused the faculty personnel to notice a change was taking place, let alone know about the change. This baseline knowledge helped characterize the engineering faculty in terms of its general awareness and openness to institutional change.

3.11. Ethical Considerations

The research plan and study were approved by the university research ethics oversight body. A significant aspect of that approval was based on protecting the anonymity of the research participants, which was the dominant ethical consideration in this study. Due to the nature of qualitative research, as well as case study research design, a lot of descriptive information was collected about a specific time, place, and space. As there are a set number of universities in Canada offering engineering programs in specific engineering disciplines, protecting the identity of the research participants was crucial, as their identities could be easily revealed given the limited possibilities for where the case study site could be located. Therefore, the university name was anonymized, any of its defining characteristics were obscured, and institutional information was made as generic as possible. Furthermore, the engineering faculty programs, courses, and titles were also anonymized or given generic labels.

The issues of anonymity most affected the mentor, host instructor, and administrator research populations. These research populations consented to interview requests, which included a discussion of their anonymity choices. Although most interviewee participants waived their right to anonymity, the anonymity of all participants was still preserved to protect that of other participants who chose to remain anonymous. Despite the great care taken to protect the anonymity of the research participants, it was still possible that they could be identified. Therefore, this was directly communicated to them during the consent procedures for each interview request with each research population.

The other ethical consideration was the multiple roles I held throughout the study, especially my role as an instructor responsible for grading the mentors enrolled in the seminar course. Therefore, I was in a direct position of power to the research participants outside the scope of the research study. To mitigate this, the mentors were informed in writing on the seminar course syllabus[50], and verbally in-class, that they could challenge any of their assignments grades. My final grading decisions were also subject to approval by a panel of engineering faculty. No issues arose. Furthermore, to ensure the data collected from the mentors was not positively skewed, I set out clear assignment criteria and grading rubrics, so it was not possible for me to award them higher grades in a bid to curry favour. I also interviewed them once most of their coursework was submitted and they already knew their projected grade bracket, to ensure they were not influenced by a desire to please me in their assessment of the curricular peer mentoring intervention.

[50] Course Syllabus is available in APPENDIX R.

The following section discusses the trustworthiness of the research, as well as my role in the research study more fully.

3.11.2. Issues of Trustworthiness

Trustworthiness of any research is determined by its validity, reliability, and generalizability, which is known in qualitative research as its credibility, dependability, and transferability (Lincoln & Guba, 1985; Merriam & Tisdell, 2016). Credibility refers to whether the perception of the phenomena under study that the research participants have is aligned with that of the researcher. Dependability is about whether the processes and procedures used to collect and interpret data is appropriate to the research question, and are clearly explained. Transferability refers to the capacity of the data findings to be useful to others in a similar scenario studied by the research (Bloomberg & Volpe, 2008).

To ensure the trustworthiness of this study, the methodology was designed to produce credible, dependable, and transferable research results. In terms of credibility, my involvement in the case study site was substantial and prolonged, providing me with an in-depth understanding of my data. I also designed multiple data collection methods, and collected data from multiple sources to triangulate the data and increase its validity (Flick, 2007). Furthermore, I also have included discrepant findings in my data analysis, and peer debriefing to enhance the accuracy of my data analysis. Finally, I fully discuss my role as a researcher, and the biases I bring to the study.

The research results are also dependable because detailed and thorough explanations of how the data were collected and analyzed are given, and the data findings are discussed at length. The collected data has also been reviewed by academics in engineering and education, ensuring the accuracy of my interpretation of the data. The transferability of the research is also strong, because there has been a significant level of detail about the curricular peer mentoring intervention given throughout the research study. Not only are there rich, thick descriptions of the intervention and how it is meant to operate, there is also extensive data on how the intervention was set up, how it was delivered, and how it was assessed.

3.11.3. Researcher Bias and Assumptions

I had three distinct roles: to design, deliver, and research, the pilot course intervention. This made my role as a researcher unique, as I was directly involved in the research – not just as a participant and observer – but also in setting up the curricular peer mentoring intervention intended to be researched through the case study site. Because of these multiple roles, I felt it was that much more important to collect data from a wide variety of sources, and as much data as possible, to negate, or at the very least minimize, any bias I would bring to my analysis of the pilot course intervention.

Design

I designed the pilot course intervention using a model of curricular peer mentoring that I had previously participated in myself at as an undergraduate student at a different university. Given my familiarity with that program, and my close ties with the faculty and administrators responsible for delivering the program, I was confident in my ability to create a similar peer-based learning program that used a curricular peer mentoring approach at the university serving as my case study site. The barriers to implementing the program have already been discussed, as has the actual content of the program.

Delivery

I could have handed off the responsibility to deliver the pilot course to an instructor (either within the engineering faculty or not) but that proved to be difficult. Whoever taught the pilot course would need to be willing to teach it, and have established teaching experience and a background in educational theory. Tenured or tenure-track faculty members would likely not choose to teach a course that they had not designed themselves, and that was extraneous to their expected teaching responsibilities, and for which they would receive no extra compensation. Sessional instructors might not have enough teaching experience to comfortably direct a seminar course and orchestrate the peer mentoring practicum. Furthermore, unless the instructor had a background in educational theory, or was willing to cultivate said background, they might not understand or appreciate the pilot course objectives and/or be able to adequately support the peer mentors in their mentoring practicum.

Therefore, I thought it would be most appropriate for me to teach the pilot course and deliver the pilot program in general because I was motivated to do it, had a comprehensive understanding of how to do it, and could troubleshoot any problems that might arise in its delivery. Finally, given the lengthy and complicated process of finding a place to run the curricular peer mentoring intervention, I did not want to incur additional complications once I had established a case study site.

Research

Even during the design and delivery of the curricular peer mentoring intervention, I was assessing the intervention. I continued that assessment following the intervention. The process was similar to action-based research, in that the research was an ongoing process, and I was a participant in the research (Cain, 2011). It did not follow a purely action-based research model, however, because it did not seek to establish a community of practice with the research participants. It also did not set out to solve a particular problem, but was more focused on putting an intervention in place to assess its effectiveness as an intervention – not its effectiveness to solve a specific concern.

Essentially, my role was multifaceted. On one hand, I was a participant-observer, and on the other I had to assume the role of an objective data analyst. Therefore, this was both beneficial and limiting to the study. It was beneficial because the data collected through interviews, surveys, and document analysis could be better understood through my observations as a researcher. Especially helpful to that analysis was the broadness of my role within the case study site, as I not only researched the intervention, but I also designed and administered it. This added a further depth and richness to my observations as a researcher.

The following section offers a discussion of the limitations of my role in the research, as well as a short overview of the general limitations to qualitative research and case study research design.

3.12. Limitations

Although there were many benefits of pervasiveness of my role within the study, there were also limitations. It was not possible to be an unbiased researcher, as the object of my research was a program I had designed based on my previous experiences as a participant in the UofC Curricular Peer Mentoring Program. Therefore, I already had an opinion about the program. I also was invested in the program, as it required a significant amount of time to design, and a great deal of time to locate a case study site. Being so close to the program, and so keen to see it successful, impacted my objectivity. However, in saying this, I endeavoured through my methodological choices to retain as much objectivity in my data analysis as possible, by collecting data from multiple research populations and through various data collection methods. When analyzing the collected data, I have also attempted to let the research participants speak for themselves as much as possible, wherever possible. I have also included a discussion of my biases as a researcher, and attempts to confine my subjectivity within that space. Furthermore, I have been clear from the first chapter of this dissertation that this was a critical study, and as such situated in critical research goals of critique and change, which are inherently biased against the status quo (Giroux, 2004).

Data gathered from case studies and qualitative studies generally, can be critiqued as lacking generalizability in answering similar research questions, or transferability to other research sites (Bogdan & Biklin, 2007). Although the goal of the research was to gain an intimate, in-depth, and deep understanding of a particular pedagogical initiative, a limitation of this study is its lack of generalizability due to its focus on a single education program, in a handful of courses in a specific faculty, at a specific university. Therefore, the implications that can be deduced from the case study of the curricular peer mentoring intervention in the engineering faculty at Maple University is specific to the experiences of the research populations within the case study site. Moreover, since the study was conducted at a single university in Canada, I cannot claim that these findings are transferable, and would occur again if the intervention was housed in an engineering faculty at another institution, in different disciplines, or with additional participants. As such, these findings cannot be applied to other engineering faculties at other institutions. Although the research findings are not generalizable, the rich data of case studies provides insights that might not be captured by other research methods.

Finally, in reference to specific research activities, there were three other limitations to this study. First, was the fact I was unable to observe all host course classes as I had initially planned. I was also unable to choose the engineering courses in which to run the pilot program. Therefore, I could not gather all the data I had intended to collect, or situate the pilot program in other engineering courses that might have proved more effective environments to run the program. Second, I would have preferred to compare the curricular peer mentoring intervention across two disciplines, but was only able to find one faculty at Maple University in which to run the program. I could not compare the intervention at Maple University with the curricular peer mentoring program at the University of Calgary either because their program does not and never has operated in their engineering faculty. Third, it was not possible for me to run the program again, which is a distinct limitation in assessing the intervention for its capacity to engender change, as change takes time and without further iterations of the program it was challenging to decidedly determine the effectiveness or ineffectiveness of the intervention in bringing about change.

3.13. Chapter Summary

This chapter reviewed the critical, interpretive research paradigm underpinning the methodology, and how these paradigms have impacted the research design. It details the qualitative and praxis-oriented case study research design, and how the case study site was selected. The chapter then gave a thorough overview of the data collection process by characterizing the research populations and outlining the sampling strategy; describing the data collection methods and rationalizing why those methods were chosen and how they were used in relation to the research populations. The chapter then goes over the data analysis procedure, speaking to the intervention and assessment research phases and the data was collected and analyzed in each phase. The chapter ends by discussing the ethical considerations relevant to the study, the trustworthiness of the research data, limitations of the study, and my role as the researcher in the study. The following chapters present data findings from both phases of the research study.

CHAPTER 4: Data Analysis: Phase 1: Intervention

4.1. Introduction

The purpose of this chapter is to review data from the first research phase of the curricular peer mentoring intervention, which is categorized under two research goals: setting up the pilot course and teaching the peer mentors. The chapter begins with an analysis of my correspondence with Professor Jackson to characterize change at a personal level, and evaluate what constitutes a change champion. It also examines change at an institutional level, by reviewing change processes within the specific organizational setting at Maple University. Data collected on the second research goal begins with a profile of each of the mentors to further characterize how they identify with engineering, and establish what personality traits make for an effective curricular peer mentor. This is followed with an analysis of how the curricular peer mentoring intervention was operationalized by the mentors within each host course, highlighting what was and was not effective.

The diagram below summarizes the research goals and data collection activities of Phase I: Intervention.

	Research Goals	**Data Collection Activities**
Phase 1: Intervention	• Set-up pilot course	• Compile correspondences • Collect course documents
	• Teach the peer mentors	• Observe the mentors • Collect course documents

Table 4: Phase I: Intervention Research Goals & Data Collection Activities

4.2. First Research Goal: Setting up the Pilot Course

The first research goal involved the development and implementation of the curricular peer mentoring intervention. Data from this stage was primarily sourced from the correspondence I had with the senior engineering administrator that assisted me in setting up the curricular peer mentoring intervention.

The purpose of analyzing the correspondence between me and the key administrator is to highlight the change process in institutional environments, as well as to better unpack the character prolife Riley (2008) offers of engineers and engineering culture and how this can prevent change in certain contexts. As discussed in Chapter 2: Literature Review, affecting change is particularly difficult within a university because of the peculiarities of their organizational structure. Attempting to manage change through a top-down approach often leads to faculty resistance (Anderson, 2011). To significantly alter the day-to-day activities of university faculty requires their full support and endorsement of a desired change. Utilizing a ‘change champion’ is one possible way to garner that support, as change champions are typically well-known, well-connected, and well-liked people within an organization that can persuade other organizational personnel that change is possible and that it will be beneficial (McGinnis, 2013).

Professor Jackson was a powerful change champion in the Faculty of Engineering at Maple University. He was known throughout the faculty, as well as the wider university senior administrative team. He was respected by his peers, which was evidenced by the way other faculty spoke about him and how they interacted with him at faculty meetings and events. He had also already led successful change initiatives in the faculty, such as restructuring the non-technical engineering undergraduate courses, changing faculty programming and grading policies to be more student-centered, establishing student-oriented faculty administrative positions, and hiring faculty not trained as engineers to teach the humanities-based engineering content required by the ECAB.

Without Professor Jackson's support, and the institutional power he held as a change champion, implementing the curricular peer mentoring intervention in the engineering faculty would not have been possible. I have collected and analyzed our correspondence to demonstrate and evaluate the vital role a change champion plays in changing an institution. I have also included these correspondences to characterize change champions in terms of their attitudes and behaviours, to better highlight how certain personality traits appear oriented towards change and specifically show engineering personalities that are emblematic of a critical engineering approach. This discussion about engineering personalities is extended later in this chapter to the curricular peer mentors, to show how they too share similar attitudes and behaviours that predispose them to being open to change, which is possible reason for their willingness to be involved in the intervention.

4.2.2. Corresponding with Professor Jackson

The first correspondence I had with Professor Jackson, the key administrator I worked with to implement the curricular peer mentoring intervention, was well in advance of the resultant correspondence that would put in motion the necessary activities to establish the pilot program and seminar course. Early into the Winter academic term, I began soliciting an audience among senior university administrators in support of running my pilot curricular peer mentoring program. I had recently completed a summer research position designing and writing curriculum for a graduate and new faculty teacher training program, and was therefore in contact with a senior university administrator who arranged a meeting on my behalf with an administrative team responsible for the development of a pedagogical policy and planning document that was due to be rolled out across the university in the coming year.

From this meeting, I was encouraged to present my curricular peer mentoring intervention initiative at various academic committees. It was also suggested that I convene a 'working group' of like-minded faculty and administrators that would be interested in assisting me in bring the curricular peer mentoring intervention to fruition. Professor Jackson was highly recommended, and the administrative office responsible for teaching and learning arranged a meeting between me and Professor Jackson, as well as a handful of other persons identified by the senior administrator. At the meeting Professor Jackson suggested it would make the most sense to establish a curricular peer mentoring pilot program and seminar course in the Faculty of Arts before placing it in other faculties given that the program *in situ* lent itself more readily for application within an arts-based course.

Although this meeting was promising, only well-wishes and general goodwill was carried forward, as there was little that could be done without faculty-wide endorsement of the program. Despite further meetings held with the Faculty of Arts, there was no official support given to the program[51]. Both the senior administrator and another high-level administrator then suggested placing the pilot program outside the arts faculty and/or

[51] Reasons for this lack of support are discussed in Chapter 3: Methodology: The Case Study Site: Barriers to Implementation

outside the university to speed up establishing a research site. At the time, one of the administrators commented that although the pilot program was perhaps better aligned with the arts faculty, placing the pilot program with the sciences might be best because it was more progressive and open to change. Unfortunately, the Faculty of Science also declined to offer any official support for the program. Therefore, the curricular peer mentoring intervention initiative remained dormant over the next year and a half when I had a chance encounter with a senior engineering undergraduate, Catherine Carol[52], looking to set-up an informal mentoring program in the engineering faculty and had been directed my way by an engineering instructor, Professor Karen King. After the meeting between me and Catherine, she wrote to Professor Jackson about my interest in being a part of the faculty's engineering initiative. The following week I was once again corresponding with Professor Jackson directly, who simply said "Let's get this show on the road" in response to the email Catherine had sent him introducing me, and my follow-up message.

I include this initial overview of introducing the curricular peer mentoring concept to Maple University faculty and administrators to show how facilitating change requires persistence. I also include it to show how being connected to people within an organization helps facilitate change, although these connections might impact on a change initiative unexpectedly, as it did in this research study. From the outset, it would be logical to hypothesize connections to high-level organizational members would be more useful for introducing organizational change as they would be better connected and better resourced. However, it was the connection I had to a low-ranking contractual teacher and

[52] Pseudonym.

the one I made through her to an undergraduate student that reconnected me to Professor Jackson, who ended up championing the curricular peer mentoring intervention. Such effects are noted in change management literature, which speaks to the importance of connections in creating change (Carter, 2013).

After being reconnected with Professor Jackson, I met with him and Catherine on Tuesday, December 3rd. At that meeting, Professor Jackson decided my initiative and Catherine's initiative were both stand-alone projects and I began working exclusively with him to set-up my curricular peer mentoring intervention in the engineering faculty for the next academic year[53]. We met again on December 12th, with Professor Karen King in attendance to discuss how my curricular peer mentoring intervention could best suit the engineering faculty. Professor Karen King was invited to attend because of her facility with humanities-based engineering courses, and I hypothesized placing the pilot in a humanities-based course setting in the engineering faculty would work best. As these two courses were required courses, built across the faculty disciplines and throughout the engineering program – reaching all junior, then all senior engineers – it was also more likely the curricular peer mentoring intervention would have a measurable effect.

At this meeting, it became clear that Professor Karen King was worried about implementing the pilot in her courses, as was Professor Jackson, as both courses were designed to respond to specific non-technical accreditation requirements and were already undergoing a redesign process. It was decided to run the pilot as a stand-alone optional

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[53] Years have been omitted to protect participant's anonymity.

course available for an engineering course credit, and open to senior engineering students. After this, I met with Professor Jackson again to present my initial course design.

Throughout our correspondence, Professor Jackson was polite, encouraging, and parsimonious. He did not demonstrate the engineering discourse described by Riley (2008, p. 44), which “privileges scientific knowledge over other kinds of knowledge, prefers certainty to uncertainty, and seeks single, simplistic explanations for complex social phenomena”, nor did he identify with an engineering culture that devalues concerns about social justice, inequality, and morality in relation to engineering practice (Cech, 2014). Instead, Professor Jackson was interested in non-technical education goals, he valued social competencies, and he verbalised the pitfalls of meritocracy. Therefore, he identified with the socially-engaged, ethically-aware, and outward looking engineering discourse described in Section 2.6.1: Critical Engineering Education. He was also keen to facilitate change by removing bureaucratic barriers, and despite his senior administrative status was willing to meaningfully engage with people below him in the academic hierarchy. Below is an email he sent me in response to our meeting:

Course development
5 messages

[redacted]
To: klord
[redacted]

[redacted]

Hi Kat,

As we discussed at our meeting, I'd like you to work with [redacted] to ensure that the course outline for the mentoring course fits into our standard template. She may also be able to provide other types of support as we develop this. Given that I'd like to get this into Faculty Council shortly after the end of this semester, you should probably get a draft to her reasonably soon. You don't need to have everything perfect since this will largely be about formatting and organizing the information and you can continue to edit afterwards.

I'd also like you to share your draft with [redacted] and discuss the readings and critical reflective pieces with her. We have moved the [redacted] course to the same semester so it will be going on at the same time and there is some overlap. It hadn't occurred to me before but perhaps students in the seminar class could even prepare something to present to the [redacted] group(s). Anyway … I'd like to encourage the exploration and discussion.

I'm really looking forward to seeing this course in action … thanks for all of your help☺

[redacted]

Figure 1: Email Correspondence 'Course Development'

This was longer than his average 1-3 line responses, and offers better insight into how Professor Jackson presents himself as an administrator and engineer. He was supportive, responsive, and reassuring. He used a smiley-face emoji to demonstrate goodwill, used phrases like "You don't need to have everything perfect…" and "I'm really looking forward to…" to show encouragement, and he was quick to connect the project to other people who could help realize its implementation. He even thanked me for my help, although it is *he* who is helping *me*, by assisting me in developing and implementing the curricular peer mentoring intervention, despite there being no guarantee that the program would address his administrative goals and educational programming objectives. This kindness and supportiveness was typical of all his emails to me, and further demonstrates his effectiveness as a change champion, as such people are generally characterized as supportive of others (Katz, 2013).

Importantly, however, he was more than encouraging: he was also aware of and keen to uphold the bureaucratic functions involved in offering a new course in the engineering faculty and university calendar. Being an effective change agent in a university setting not only means inspiring people to change instead of using rank or status to force change, but also being able to navigate hierarchy and bureaucracy effectively (Anderson, 2011). Professor Jackson demonstrated his understanding of the university institution, wherein meeting all bureaucratic requirements can pre-empt resistance to change from others who would cite failure to comply to bureaucratic standards as reason to deny change. His views on facilitating change despite the impediment of extensive bureaucracy and resistant organizational culture are captured in the interview he participated in, and can be found in Chapter 5.

Professor Jackson's sentiments regarding change featured in our further correspondence. I sent him an email updating him how the course outline was being developed to adhere to the traditional engineering format, and respond to the learning objectives sought by the engineering accreditation board. This email also informed him of my involvement with a small workshop being run for graduate engineering students by Professor Karen King in conjunction with like-minded faculty members in support of an innovative engineering education research project focused on building the non-technical skill set of engineering students. He told me he was glad that I was involved with the research project, saying "Sometimes it almost seems like things are moving forwards☺". I include this exchange, because his comment directly references other comments he had made about the difficulties involved with setting up the engineering curricular peer mentoring pilot course in some of our face-to-face meetings. Such comments help demonstrate the reality of change processes: they take time, are piecemeal, and tenuous.

Throughout this time, I continued to develop the course, and correspond with Professor Jackson. I sent my completed course outline to Professor Jackson to finalize my course. By then, I had also completed my ethics application in support of running the course for research purposes, as well as developed informal application process and program information to distribute via the engineering faculty communication networks. Professor Jackson then contacted me to confirm the pilot program was still going ahead.

We then set a meeting with Dr. William Wessel, who administered the first-year engineering experience. Following this meeting, I again sent in the course materials created over the summer in support of advertising the program to engineering students. It was important to move quickly with this, as Professor Jackson had said engineering students mapped out their course selections up to a year in advance. Because of this, all course materials were finalized for review, so advertising for the pilot curricular peer mentoring program could take place before students had made their course selections. Despite the lengthy official internal faculty processes and larger university administrative hurdles

the pilot course was listed in time for students to choose it over another course.

However, it had not been advertised to students in advance of the course registration date. Therefore, Professor Jackson sent out a note to all engineering senior students to encourage them to select the pilot course as one of their limited senior elective courses. In the end, only 3 students registered, which was a low number, but not unexpected, given

Professor Jackson had observed that most students map out their elective courses months to years in advance.

[redacted]

RE: [redacted] Mentorship in Engineering

I have attached a course outline and some other details for a newly approved pilot course that we are offering next semester. This is quite a unique offering and I encourage you to consider it if you are interested in developing your leadership skills and/or in mentoring junior students. I believe that the attached documentation explains the details. It is a normal credit course which can be considered in the place of a free elective. Please don't hesitate to contact me if you have any questions after you have reviewed the attached information.

Regards,

[redacted]

Figure 2: Email Correspondence 'Student List-serv notification'

In summary, I have included my email exchanges with Professor Jackson to demonstrate his behaviour towards me is a clear indication that he did not respond to, or endorse, the three ideological pillars outlined by Cech (2014, p. 45) that act to devalue concerns about social justice, inequality, and morality in relation to engineering practice. If Professor Jackson bought into the ideology of depoliticization, which frames any 'non-technical' concerns such as public welfare as irrelevant to 'real' engineering work, he would not have been supportive of my pilot course (or the many other progressive engineering education projects with which he is involved) because these non-technical concerns formed the basis of the curricular peer mentoring seminar course and were the objective of the mentoring practicum. He is an engineer who values 'social' competencies, because he was interested in the ability of my curricular peer mentoring intervention to develop the social competencies of engineering students. He also recognized the meritocratic ideology that frames existing social structures as unfair, which was made clear in my face-to-face meetings with him throughout the curricular peer mentoring intervention and the final interview I conducted with him after it ended. Therefore, although Professor Jackson does not deny the existence of the engineering culture discussed in Chapter 2, he shares the same progressive outlook advanced by engineering educators such as and Baillie and Catalano (2009a, 2009b), Cech (2014) and Riley (2008) among others.

Secondly, the correspondence shows a change process in action. As previously discussed in Chapter 2, one of the key barriers to change within the university is *structural inertia*, which concerns the mechanisms built into the institution that create stability, such as explicit procedures that are formalized within the institution (i.e. adding a new course offering to the university calendar) to those that are implicit within underlying institutional assumptions and cultural practices (ex. valuing disciplinarity over interdisciplinarity). This is often further reinforced by *group inertia*, which develops when specific group norms solidify resistance to change, and can include leadership inaction, collective action problems, and cynicism. (Strydom et al., 2004).

As the correspondence with Professor Jackson shows, even when people want to facilitate change, the structure of the university limits the quickness and/or possibility of that change taking place. Not only did I have to ensure my pilot course was developed in keeping with the standard engineering course framework, it also had to pass through a series of official university bodies to be approved. It was also important that I complete my work in a timely fashion, and continually follow-up with Professor Jackson to keep the process moving, as his administrative responsibilities were demanding and time-consuming. I had to work to a high standard, meet deadlines, and be clear in my communications, so Professor Jackson did not have to wait on me, and so as not to annoy him and risk him stepping away from the project. I also had to maintain regular contact with Professor Jackson to ensure he understood my intentions were serious, and to guard against the pilot getting side-tracked or consumed by structural inertia.

Luckily, I did not encounter group inertia in this process. However, that group inertia was a key barrier when I first proposed the program to the Faculty of Arts and Faculty of Science. If I had not had meet Professor Jackson, and if Professor Jackson had ascribed to the engineering discourse described by Cech (2014) and Riley (2008) as narrowly focused on technical outcomes and unconcerned with the potential social and ethical impacts of engineering, it would be unlikely that my curricular peer mentoring intervention would have been implemented within a university environment. Professor Jackson was someone who had the necessary status within the university – status I did not have – to lead a change; he was aware of, but not defeated by, the structural inertia within the university system; and he was not disparaging of woman, or non-technical education goals and objectives.

4.2.3 Meeting the Mentors

The term began on Monday January 5, 2015. Prior to the term beginning, three senior undergraduate engineering students had applied to the program. Students were not asked to complete a formal application form (i.e. a fill-in-the-blank document), instead the program overview that was sent out to students via Professor Jackson's email asked them to send an informal email that included their contact information as well as their engineering program information. The application process was based off the University of

Calgary Arts Peer Mentoring Network program, as their program is well-established. This helped ensure that the first interactions the students applying to the curricular peer mentoring pilot program and seminar course had was predicated on a well-formulated and previously used application process. Adopting the professional style and tone used by the UofC program may have also helped legitimize the pilot program for interested engineering students, and help attract more students to sign up for a non-technical elective.

In the program overview document, I had listed the qualifications expected of the students applying to be mentors. Along with the perfunctory qualifications asked for (i.e. being a senior student, having a high GPA, being able to fully commit the seminar class and practicum hours, and having previously taken the host course as a student) were two other ‘personality trait’ criterions concerning working well in a team and being self-directed.

To apply students were not asked to respond these criteria at all, but all three students who applied responded to these points voluntarily. This indicates that the students had the ability to act and think independently, which would be important for their mentoring practice given they would have to be comfortable leading their peers. Their engagement of the personality trait criteria, and in general their submission of applications that went above and beyond what was asked of them, which also indicated that they were committed to the program goals and intentions. Furthermore, their applications also provided insight into their characters, which was useful during the running of the program, and is a valuable addition to this research data.

Katy Knightly

Katy sent her application in less than six hours after Professor Jackson had circulated his email among the senior undergraduate engineering students. He sent his email at 4:56pm and Katy submitted her application at 10:32pm the same day. Katy not only responded quickly to the email note on the program, she also formulated her own ‘formal application’ for submission to the program. This provided immediate insight into her character: she worked efficiently, she was highly organized, and confident. The text of her application was even more informative. First, she responded to the perfunctory questions, bolding the text to ensure it was easy to locate the profile information requested. Doing this indicated that she was empathetic. She wrote the application to make it easier for the program coordinator to obtain the information needed by compiling all the pertinent information in one place. She then provided a brief synopsis of her background, using bullet points to organize the information, and choosing three specific examples outlining her leadership experience. Again, she made sure to use formatting to highlight important information and differentiate between subject matter. She referred to the specific activities involved in each extracurricular role, to demonstrate the extent of her experience

In doing so, she further demonstrated her competence in organizing her thoughts and subsequent communications with others. She went on the explain her background examples in the context of why she wanted to participate in the program

Katy demonstrates the high personal standards she has of herself and her work by providing further information. Importantly, she also shows that she is socially aware and perceptive. At no point, did I request any more information than an applicant's contact information and a brief profile of their engineering status (discipline, year of study). This was a conscious decision not to scare off good applicants who might be deterred by extensive communication with an unknown person given that research has shown that some engineers struggle with social interactions (Riley, 2008). From reading the program overview document, however, Katy understood that responding to the "Qualifications" section would be helpful. She also intuited from the program overview that speaking to her interest and/or experience with teaching and learning activities, and her ability to work with her peers was be valuable information for me, as the program coordinator, to have. The program overview is not overly loquacious on the topic of teaching and learning, or the ins and outs of peer mentoring. Katy, however, expertly read between the lines, and submitted an application that was responsive to the direct and indirect request it makes.

Katy, like Professor Jackson, epitomized the best aspects of traditional engineering discourses. When Riley (2008) discusses well-known engineering jokes to illustrate how engineers think and behave, she is clear that in many of the jokes there is a positive and a negative interpretation. For example, Riley (2008) describes a joke about an engineer about to be executed by guillotine, but the guillotine is faulty, and a lawyer and a priest have already escaped fate arguing 'double jeopardy' and 'divine intervention' means they have to be let go. The engineer, however, says "Wait! I think I see your problem…" The negative attribute here is the willingness to accept authority – even at your own peril. The positive attributes, however, are the problem-solving abilities engineers have, and their sense of altruism when using those abilities. Riley (2008) uses engineering jokes to show:

- A post-positivist epistemology is unhelpful if it's the only standpoint an engineer adopts for understanding all problems (i.e. only objective knowledge or scientific methods are valued, subjective knowledge or interpretive methods are discredited), but valuable for addressing technical problems
- Having an exclusively technological approach to the world can cause engineers to devalue social relationships and personal enjoyment, but constantly analyzing or working indicates also demonstrates a strong work ethic
- Having an overly practical mindset may cause engineers to the point they lack basic compassion, but their practicality can also help them solve technical problems

Katy's application demonstrated many of these positive attributes of traditional engineering discourses. Firstly, she was focused on identifying and solving problems. She commented about the lack of Maple University's presence in Canadian student engineering, and why that was a problem for her cohort. She then worked to change the situation. Her motivation was altruistic since she was no longer a junior student and the work she did would most benefit current and future junior students. Secondly, she had a practical mindset, but knew when to apply it and when to relax her technical approach. This was evidenced by how she formatted her application to be easy to locate important information (technical) – and – how she provided additional information supporting her application (social).

Cliff Compton

Cliff's submission began with a brief introduction, and then a short discussion of some of the previous and current leadership roles he had held as an undergraduate student. Like Katy, he was skilled at reading between the lines of the program overview and requested application information. He made it clear that he understood what was required of him as an applicant to the pilot course and the associated practicum component was a supportive approach to first-year engineering students and a friendly attitude:

"I think that this course will be a good way for us senior students to further develop our skills while concurrently helping out the junior students through a tough first year . . . First year can be daunting but I think that having student mentors in the classes can help bridge the gap with faculty and at the same time make the students feel welcomed into the engineering community."

Cliff then signed off his email by listing his contact information in a similar fashion to Katy. Although Cliff's submission was shorter than Katy's, it was still well-thought out and presented. His submission came in a full week after the notification about the program was sent out by Professor Jackson. He seemed like a good fit for the program, and like Katy, his communication style was well-developed, he was personable, and he was sensitive to subtext, which seemed to indicate he was at ease with social interactions.

Claire Clark

Claire's submission came in two weeks after the initial call-out for applicants. Her application was the shortest, but like those of Katy and Cliff, it was still well-organized and written with her audience in mind. With Claire's application, it was clear that she had a definite objective in mind when applying for the curricular peer mentoring program and seminar course. She was interested in a management career, and identified her leadership skills as an important area of personal development. In this, she was different their Katy and Cliff. She was a ‘mature’ student in that she had already completed a university degree, and was already working in a professional capacity as an engineer. Her application also indicated that she was worried about her leadership skill set, and that she perceived this as a barrier to her career goals and professional progression.

Further observations confirmed this, as she was struggling in her current workplace to obtain leadership opportunities and to be given the type of responsibilities she felt prepared for, but was yet to receive. Claire’s experience therefore became an important backdrop to the course content, as through the course readings and discussion she discovered it was not her leadership skill set that was a barrier to her professional goals, as much as it was her sexist working environment. This discovery was amplified by her practicum placement in her host course, wherein she reported experiencing a similar lack of recognition and respect, which she attributed to her gender.

In conclusion, all three students who applied to the program were submitted on the merit of their applications. Despite a small applicant pool, which may be attributed to the late notification students received (a result of administrative delays outside my control) applicants were still selected based on personal qualities such as their commitment to the program expectations, an understanding and appreciation of the program goals and objectives, a desire to assist their peers, and personal integrity. Applicants were also expected to be high-achieving students, who had relevant leadership experience to bring to the program or committed to developing their leadership skills. All three applicants met these criteria. Furthermore, they were proactive in obtaining the necessary administrative documents required to enter the course, and contacted me well in advance of the course start date with their applications.

Their applications are an important component of the data collected on the mentors, and formed the foundation of further observations of them in the program. The mentors are a crucial research population, and a link to the student, faculty, and administrative research populations. The following section will discuss the observations made of the mentors within the first half of the seminar course, which were then used to create a ‘leadership profile’ which was shared with them mid-semester. This leadership profile also included a ‘personal growth challenge’ unique to each mentor, which was then acted on and reviewed at the end of term through their submission of a critical reflection summarizing their “Leadership Philosophy”.

4.3 Second Research Goal: Teaching the Peer Mentors

The second research goal concerned teaching the mentors, and subsequently encompassed observations of the peer mentors in the seminar course, and their practicum placement within their host courses. Observational data was also included as a data source for the first phase of the research program, along with the course documents. The relevant data associated with this research phase comprises all course documents. That includes the course description, course advertisements, course syllabus[54], course application materials

[54] Course Syllabus is available in APPENDIX R.

and application submissions, as well the intake surveys and personality tests completed and returned by the mentors, and the mentor leadership profiles made by the researcher.

4.3.1. Intake Surveys

Leading up to our first class, each mentor completed an intake survey based on a previous survey used by Professor Karen King, when she hosted an engineering student workshop. This survey asked them about their current program information, and basic demographic information including their residency status in Canada, how long they had lived in the province, plus their school and work history. It also assessed their values and motivations in choosing to pursue an engineering degree and their future aspirations upon leaving their program. These were assessed using a check-box list of possible answers to two questions “Why did you initially decide to study engineering?” and “My plans for the future are to…” as well as a Likert scale rating their agreement with a series of statements about what is important to them personally and the factors that have influenced them to persist in their engineering education.

All three mentors were Canadian, in full-time studies, and senior engineering students. They were all Canadian citizens, and all of them indicated their identity was tied to their province of origin, which they had lived in since birth. Katy also noted she identified as First Nations, Inuit, or Metis, later specifying that she was a member of a specific First Nations band[55]. Although she disclosed her Indigenous heritage on the Intake Survey, she was not keen to discuss it further. Her reluctance to openly claim her identity among her peers and professors may be indicative of the Canadian academic institutional culture

[55]First Nations band name not disclosed due for confidentiality purposes.

towards Indigenous persons and knowledges. This analysis is also supported by the interview data collected from Professor Jackson, reported in Chapter 5, whereby he discusses his concerns about engineering culture and its negative effect on Indigenous engineering students and academics who he believes choose to keep their ethnic background private to avoid discrimination. Along with this basic demographic information, each mentor was also asked to respond to a series of questions about their values and motivations, their general life goals, as well as their decision to pursue engineering. In the first series of questions they were asked to simple check the statements with which they agree. The mentor responses are summarized below:

Why did you initially decide to study engineering?	**KATY**	**CLIFF**	**CLAIRE**
Attracted by the challenge of a difficult curriculum	x	x	x
Good at math or science	x	x	
High school adviser or teacher recommended it	x		
Like to solve problems	x	x	
Participated in engineering camp or workshop that influenced me		x	
Parent, other relative, or friend is an engineer			x
Parent, sibling, or other relative recommended it			
Received or anticipated possibility of good university scholarship			
Wanted to be able to get a well-paying job after I graduate	x	x	x
Wanted to use engineering solutions to address social problems	x		
Not sure			

Table 5: Question for Mentors 'Why did you decide to be an engineer?'

It was interesting to note that all three mentors agreed that they were attracted by the difficulty of the curriculum, and the desire to obtain a well-paying job upon graduation. These responses are in keeping with the engineer profile discussed at length in Chapter 2: Literature Review. Most engineering students are committed learners, and it is not surprising that challenging curriculum would attract them to engineering studies. Many also have a practical nature, which is indicated by the focus the senior undergraduate engineering peer mentors placed on securing jobs that are well-compensated.

The mentors also provided their own story about choosing to become engineers, which helps explain why Claire is the sole person who indicated that she decided on engineering due to a relative being in the profession. She speaks about the importance that her grandfather, himself an engineer, had on her as a young girl. It is interesting to note that unlike Katy and Cliff, she did not identify as ‘being good’ a math or science, which is something she spoke about throughout the course, choosing to complete a second university degree in engineering to secure better employment opportunities. It is also interesting to note that she does not indicate ‘liking to solve problems’ to be a draw for study. These responses make her atypical from the other mentors, as her responses indicate that undertaking engineering studies was more a personal and a practical decision, than a decision resulting from an innate attraction to the discipline and profession. For example, Katy and Cliff both discuss in the stories an attraction to science and maths, a common narrative in engineering (Pawley, 2009); whereas Claire identifies an attraction to the type of person and life she wants to live.

When discussing their future, all three are clear they want to work in industry. Katy and Cliff also want to pursue their MBA. Since Claire had already obtained a business degree, she did not indicate this. It is not surprising, however, that obtaining an MBA or already having a business degree qualification, characterized the mentors as the popularity of obtaining an MBA as an engineering undergraduate at Maple University was widespread enough to initiate the development of an MBA program specifically for engineering graduates.

My plans for the future are to:	KATY	CLIFF	CLAIRE
Work in industry	x	x	x
Work in a government lab or agency			
Continue engineering graduate studies			
Go on to a professional school (e.g., medicine, law)			
Pursue a Masters of Business	x	x	
Administration (MBA)			
Teach in K-12 schools			
Teach at the college level			
Teach at the university level			
Become a professor			
Participate in a business start-up or start my own business	x		x
Enter (or re-enter) the military			
Do research in a corporate lab			
Work for/start a non-profit or charitable organization			
Undecided			

Table 6: Question for Mentors 'What are your future plans?'

After indicating their values and motivations for enrolling in an engineering undergraduate program, they were asked to respond to a second series of questions and rate their responses to a series of statements about their personal goals on a Likert Scale, with '1' being Not Important, '2' being Somewhat Important, and '3' being Important, and '4' being Very Important. These responses are summarized below:

Indicate the importance to you personally for each of the following:	**KATY**	**CLIFF**	**CLAIRE**
Becoming accomplished in one of the performing arts	1	1	1
Obtaining recognition from my colleagues for contributions to my field of expertise	2	2	3
Having influence in political decision-making processes	2	1	1
Raising a family	4	3	3
Having administrative responsibility for the work of others (e.g., project management)	4	4	3
Being well-off financially	4	4	4
Helping others who are in difficulty	4	3	3
Making a theoretical contribution to knowledge in engineering or science	2	2	2
Writing original works (poems, novels, short stories, etc.)	1	1	3
Creating artistic works (painting, sculpture, photography, etc.)	1	1	4
Becoming successful in a business of my own	4	3	3
Working for a company or organization with a strong sense of corporate social responsibility	3	2	3
Working for extended periods in another country	2	2	1
Working for a company or organization with a strong sense of sustainable design	2	3	3
Developing a meaningful philosophy of life	2	1	3
Engaging in volunteer work in my community	4	3	2
Keeping up to date with political affairs	1	1	1
Integrating spirituality in my life	1	1	3
Improving my understanding of other countries and cultures	2	2	2

Table 7: Question for Mentors 'What is important to you?'

The responses from each mentor were similar for most statements, with the biggest discrepancies being Claire's identification as *writing original works* and *creating artistic works* as 'Important' and 'Very Important' to her, which is highlighted in her story wherein she mentions colouring as a child when accompanying her grandfather to work at his engineering company. In keeping with the observations of Katy as people-oriented and a leader in the student engineering community, she identified a clear desire to *help others in difficulty*, and *engage in volunteer work* in her community.

Therefore, it was not surprising to see that she also placed great importance on *helping others in financial difficulty*, given her consistent orientation towards her communities. The positive attributes of the engineer profile are characterized by a desire to help others (Riley, 2008), which is also indicated as 'Important' by Cliff and Claire. Again, that it is 'Very Important' to all mentors to be *well off financially* is not surprising, especially given the economy within their geographical region has been historically disadvantaged compared to other areas in Canada.

In the second series of questions they were asked to rate their responses to statements about their persistence in engineering education on a Likert Scale, with '0' being No Influence, '2' being Small Influence, and '3' being Moderate Influence and '4' being Significant Influence. Their responses are summarized below:

Indicate the degree of importance that the following factors have had in your persistence in engineering:	KATY	CLIFF	CLAIRE
Sufficient opportunities for financial aid or scholarships	1	1	3
Engineering faculty/departmental personnel show an interest in me	2	0	1
Reasonable workload for courses and research	1	1	1
Friendly climate in classes, lab and/or department	1	1	2
Satisfactory performance on my grades	2	2	2
Faculty help me understand what practicing engineers do	1	2	1
Good teaching by faculty and instructors	2	3	2
Effective advising and supervision by engineering faculty	2	2	1
My personal abilities/talents "fit" the requirements in engineering	3	1	2
Positive interactions with other engineering students	3	2	2
Family support and encouragement	1	3	3
Family expectations (i.e. it is important to my family that I persist in engineering)	0	2	1
Cultural expectations (i.e. it is important in my culture that I persist in engineering)	0	0	1

Table 8: Question for Mentors 'Why have you persisted in engineering?'

Again, there were more similarities in the answers from the mentors to the questions regarding their persistence in engineering than there were differences. None of the mentors identified any of the statements as holding 'Significant Influence' over the persistence in engineering, and all of them indicated perfunctory aspects of education provision (*effective advising, good teaching)* as having 'Somewhat' to 'Moderate' influence in that decision. The only major discrepancy was Claire identifying *sufficient opportunities for financial aid or scholarships* as having 'Moderate Influence' on her decision to persist in her studies – a factor that was probably more important for her than her peer group as she no longer lived at home and had already financed a previous university degree. The other notable discrepancy was Cliff and Claire indicating that their *family support and encouragement* had a small or moderate influence in their persistence to continue in their engineering education, whereas Katy did not identify that as influential.

The Intake Survey also included a written component, which asked them to write a short story about something significant that influenced their choice to study engineering. These stories provided a further, personal, characterization of the above intake survey data. The stories related by each of the mentors also underpinned the initial program applications. They are copied in full below:

KATY

In middle school (Grades 7-9) I had one particular teacher who really opened my eyes to not engineering in particular, but to science and its possibilities. I can remember the day, sitting in the back of her classroom, it was chemistry class. We were discussing atoms and although the discussion was very basic, I was intrigued. The world provides so many opportunities for learning and all we have to do is reach out and take them. This teacher was engaging in her teaching, it wasn't just sitting in class and taking notes, it was everyone dancing until the energy in the room was so great that the "big bang" happened. It was being assigned an element and having to find another element to bond with and properly stand such that the bonds were on the correct angles. I realized that I loved engaging science. Science that you can continuously grow from. That is what led me to *engineering, in particular to process engineering where chemistry is so dominant. Many years later, when I was in my second year of engineering, I returned to that school. This time I entered that room as an educator with the not for profit group Let's Talk Science. This group design educational, yet engaging presentations for young students. The goal is to help give these individuals some insight to the sciences and their application. Giving this presentation allowed me to show this teacher, who had given me so much, something in return. I got to show her how significant her teachings were to my development. She is someone I will never forget and someone I will always be grateful for crossings paths with as she helped shape who I am as a person.*

CLIFF

When I was a child I always loved Legos, which allowed me to build + design whatever I wanted. Mom recognized this and every year I got a 5000+ piece set to build a ship/car etc. I think this really sparked my interests moving forward as I began taking apart household items such as the clock. In high school I took a great interest to physics, specifically in Kinematics + Dynamics. I spoke to my teacher about it and realized that engineering is where these concepts are applied to the real world. Before engineering I didn't know what I wanted to do, just to dive in, learn stuff and figure out my job plan later.

CLAIRE

Throughout my life my grandfather was always and will continue to be my role model. My mother had her hands full with two babies less than a year apart while my dad was a *farmer at the time. My grandfather lived right next door & for the most part raised me. He was a civil engineer who owned his own company with his brothers that his father started. He used to take me to work with him on a regular basis where I would patiently sit & colour while he was in meetings. Growing up, he would teach me how things were made and built. He always set goals & always achieved them all the while impacting the people around him in a positive way. He handled failure well! With the attitude that he would try harder next time. He was not only role model for engineering, but in life. He is greatly missed.*

Katy's story further underpins her initial Intake Survey data, as she highlights her natural attraction towards science. Her story also highlights the importance she places on her relationships and serving her community, as well as her desire to be a leader among her peers. Cliff's story builds on his Intake Survey data as it describes his love of building as a young child and how that led him to choose engineering as a career. Claire's story highlights her Intake Survey data in a different manner than that of Katy and Cliff, as she focuses on her artistic pursuits, how her grandfather was self-employed, as well as his attitude towards goal-setting and responding to failure. This corresponds to her survey data wherein she notes the personal importance she places on her art, as well as her desire to own her own business, and her persistence in engineering studies despite not identifying a nature aptitude for maths and sciences.

On a final note, it is interesting to see how Katy notes her interest in theoretical science and chemistry, and has ended up in process/chemical engineering, which is the most abstruse of the engineering disciplines. Cliff, however, is a mechanical engineering student, which reflects his childhood love of building, as mechanical engineering is the most ‘hands-on’ of the engineering disciplines. Claire is a civil engineer, and in her story, she notes the importance her grandfather, who was also a civil engineer, played in her life.

Again, it is interesting to note that Claire does not relate a narrative that tallies with the work by Pawley (2009), who found the most comment narratives engineering faculty use to speak about themselves and their work presents engineering as applied science and math, problem solving, and making things. Katy and Cliff present these narratives, and relate how early in their lives they became attracted to sciences, math, problem-solving and making things. Claire also indicates her interest in engineering happened at an early age, but her story makes it clear the attraction to the profession was due to a personal connection to another person – not the subject matter. She is also the only mentor who notes a personal interest in arts-based pursuits, and holds a previous degree in the social sciences.

4.3.2. Personality Tests

These stories also informed the personality tests they were asked to complete upon entering the program. Alongside the Intake Survey, I asked the mentors to complete a series of personality tests: Myers Briggs Personality Assessment, Keirsey Temperament Type Assessment, the Big Five Personality Type Assessment, and a Working Style Inventory Assessment. These assessments are considered psychometric tests, which are “instruments designed to produce a quantitative assessment of some psychological attribute or attributes” (BPS, 2016).

The personality tests served two purposes. First, it encouraged further self-awareness among the mentors, and spurred their own change process by highlighting their strengths, but also their opportunities for growth, as leaders. As change is difficult for people, having a range of personality tests that outlined these areas of personal development provided overwhelming evidence to the mentors about their own need for change. Secondly, the tests results could later be compared to each mentor's participation and efficacy in their mentoring role at the end of the pilot program, and thus provide insight into what types of personalities are best suited to curricular peer mentoring.

Of the available personality tests, there are two main types: those that measure ability, aptitude or attainment and those designed to assess personal qualities such as personality, beliefs, values or interests, motivation or drive. The tests I administered to the mentors were personality tests, which can help predict how people are likely to act or react under different circumstances (Carter, 2007). Therefore, these tests are widely used in education and/or management to assess students and/or employees as they produce measures obtained under standardised assessment conditions which have known reliability and validity (BPS, 2016).[56]

For the purposes of this study, it is important to understand the personalities of the mentors, so I could tailor my teaching style and learning materials to them. I also wanted to use their personality assessments to anticipate any issues with the mentoring duties

[56] The resultant discussion on personality types is not intended to assert that there is an 'ideal' type of peer mentor, or a set of traits best suited to mentoring. The use of personality profiles was a useful way to engage the mentors in critical reflection about their own performativity as engineers. How these traits influenced their practice as mentors is discussed to question whether the advantages/disadvantages the mentors experienced when mentoring correlated to aspects of their personalities that they were aware of and/or perceived to be an area of strength or personal development.

they might have, and have them refer to it in their critical reflection activities in the seminar course. Finally, I wanted to add these assessments to my profiling data, to check it against aspects of some of the traditional engineering discourses discussed by Riley (2008), and determine if the mentors in the course were similar or different in personality from these traditional engineering discourses. This could then be used to further understand and discuss the whether certain aspects of traditional engineering discourses among engineering faculty might pose barriers to institutional change.

The *Myers Briggs (MBTI) Personality Assessment* is based on Carl Jung's theory that the human mind is involved in Perceiving (P) or Judging (J), with perceiving about the taking in or collecting of information and judging being the organization and use of that information to make conclusions (Moretto, 1995). Human beings perceive in two different ways: Sensing (S) or Intuition (N). There are also two different ways of judging: Thinking (T) or Feeling (F). People with a preference for perceiving tend to be flexible, open-minded, spontaneous and respond to new information. Whereas, people with a preference for judging like things to be structured, planned orderly or completed. Those who use sensing over intuition are more likely to be practical, realistic, and present-oriented instead of big picture thinkers who are imaginative and future-oriented (Rosati, 1997). Finally, those whose judging preferences run towards thinking tend to be analytical, objective, impersonal and logical problem solvers. Whereas, those whose make decisions based on feeling are typically sympathetic, compassionate, and value-oriented (Moretto, 1995). How a person relates to their external and internal realities is categorized by whether they are energized by interaction outside themselves, known as

Extraversion (E), or if they are energized by their inner world of reflection, ideas, and emotions, which is known as Introversion (I) (Moretto, 1995).

Therefore, a MBTI personality assessment would lead to a personality type profile that combines these binaries based on the dominance of one trait over the other, leading to a four-letter abbreviation of any given personality type, such as “ISFP” for *Introverted, Sensing, Thinking, Judging*. People use all four cognitive functions; however, they have a dominant function (either *Introversion* or *Extroversion*) that is supported by an auxiliary function (*Sensing* or *Intuition* combined with *Feeling* or *Thinking*), which is known as a ‘function pair’ (MBTI, 2016). The function pair can be *Sensing* plus *Thinking* (ST), *Sensing* plus *Feeling* (SF), *Intuition* plus *Feeling* (NF), or *Intuition* plus *Thinking* (NT). The tertiary function is not included in the type abbreviation, but it is the opposite of the auxiliary function. For example, if your auxiliary function is *Sensing*, then your tertiary type is *Intuition*. It is not well-utilized, and usually is developed later in life. The fourth function is the least conscious function, and is called the ‘inferior function’ and can emerge without conscious intention and attempt to overpower the dominant and auxiliary functions – especially when a person is stressed (Quenk, 2016). Each of these cognitive functions can be combined into 16 possible MBTI personality types.

Research has shown that engineering attracts introverts, thinking and judging types (Bannerot, 2009; Rosati, 1997). This is hardly surprising given the work engineers are engaged in requires idea generation and reflection on said ideas (i.e. when formulating a new design), as well as a structured and orderly process to realize those ideas, which is best facilitated by an analytical, objective and logical problem-solving approach. It is also interesting to note, that students who are academically weak are more likely to succeed in their first-year of engineering studies if their personality types are *Introverted, Intuitive, Thinking, and Judging* (INTJ) and attrition is higher for those with *Extraversion*, *Sensing*, *Feeling*, *Perceiving* (ESFP) type preferences (Rosati, 1997). Furthermore, engineering students are more likely to graduate from an engineering program if they are predominately ISTJ, ESTJ, or S-, T-, J-, and SJ- dominant (Bannerot, 2009). Therefore, it was interesting to see that two of the mentors showed slightly atypical MBTI preferences for engineering students:

KATY

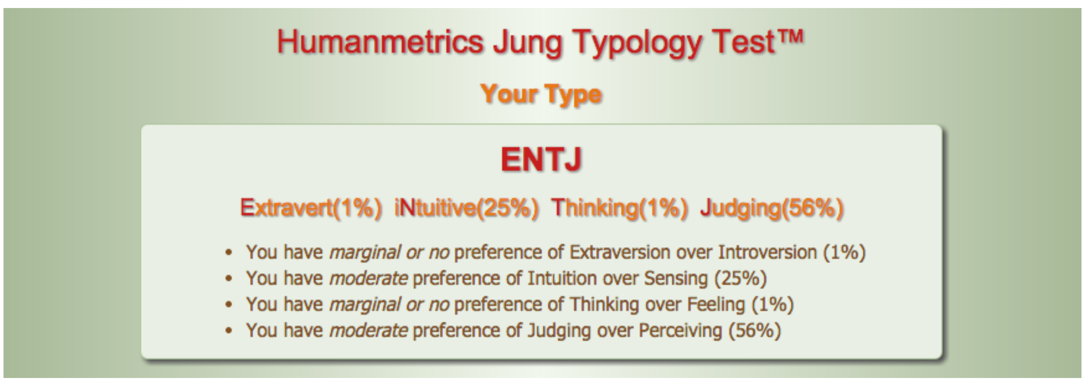


Figure 3: MBTI Profile 'Katy'

CLIFF

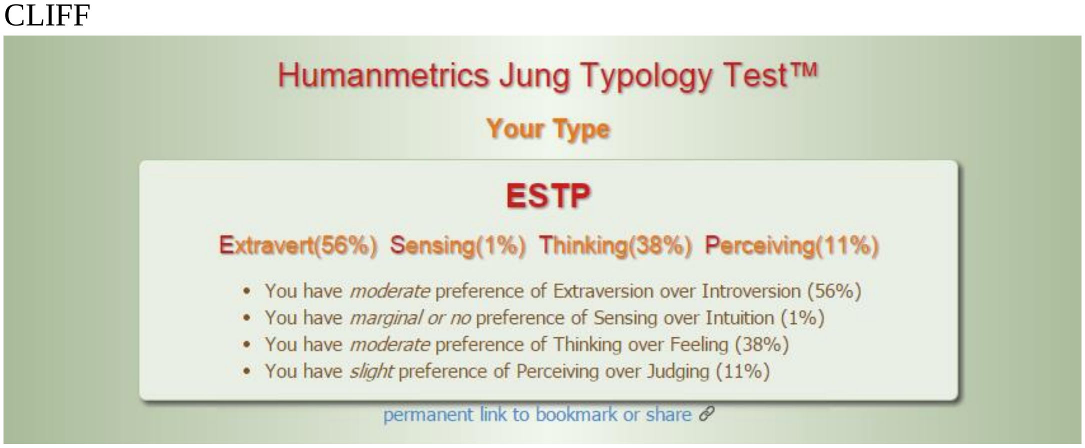
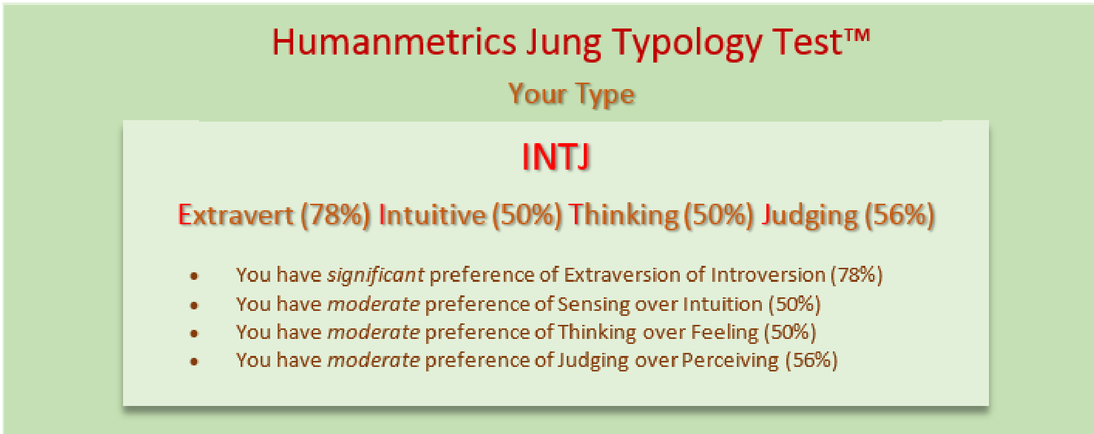


Figure 4: MBTI Profile 'Cliff'

CLAIRE


Humanmetrics Jung Typology Test™

Your Type

INTJ

Extravert (78%) Intuitive (50%) Thinking (50%) Judging (56%)

- You have *significant* preference of Extraversion of Introversion (78%)
- You have *moderate* preference of Sensing over Intuition (50%)
- You have *moderate* preference of Thinking over Feeling (50%)
- You have *moderate* preference of Judging over Perceiving (56%)

Figure 5: MBTI Profile 'Claire'

It was not surprising, however, to see that Katy and Cliff were categorized as Extraverts, however, marginally, as both were actively engaged with their communities. Throughout the course of the curricular peer mentoring intervention, Katy remained true to my first impressions of her, being consistently organized, proactive, and following through to completion all the activities and work associated with the program in a timely and structured fashion. This is demonstrative of her preference for judging over perceiving. She was clearly liked to have things decided, was task-oriented, kept lists of things she needed to do, made sure to complete her work – often doing so in advance of deadlines (Martin, 2016). On the other hand, as noted by Cliff himself in his critical reflections, he was often late to class, inconsistent in meeting deadlines, and not particularly organized. Therefore, he demonstrated the traits of someone with a preference for perceiving: a tendency to be unorganized, a casual approach to planning and work, and a tendency to work in bursts of energy and/or in response to approaching deadlines (Martin, 2016). It is also interesting to note his laissez-faire attitude towards the career plan in the Intake Survey, as this is also a personality trait associated with his MBTI profile.

Unlike Katy and Cliff, Claire demonstrated a typical engineering personality profile, as an INTJ. Her scores for each scale were: Introvert (78%) Intuitive (50%) Thinking (50%) Judging (56%). Interestingly, Claire was also the only mentor who was not actively engaged in extracurricular activities, which aligns with her strong preference for introversion. Negotiating this preference, however, was clearly a strong motivating factor for her to join the program as she had already self-identified her weaknesses with leadership and interactivity when first applying to the program. Working with her introverted personality would be an ongoing struggle for Claire throughout the practicum component of the curricular peer mentoring pilot program, which was exacerbated by her placement with an unhelpful host instructor.

The *Keirsey Temperament Type Assessment* is an extension of the MBTI that categorizes the 16 possible types into four categories: Idealist, Guardian, Rational and Artisan. Artisans are fun-loving, optimistic, realistic, and focused on the here and now. They pride themselves on being unconventional, bold, and spontaneous, are excitable, trust their impulses, seek stimulation, and prize freedom. Idealists are enthusiastic, intuitive, romantic and people-oriented. They are focused on personal journeys and human potentials. Guardians are dependable, helpful, and hard-working, tending to be dutiful, cautious, humble, and focused on credentials and traditions. They trust authority and seek security. Rationalists are pragmatic, sceptical, self-contained, and focused on problem-solving and systems analysis. They pride themselves on being ingenious, independent, and are strong willed, trust logic, yearn for achievement, seek knowledge, prize technology, and dream of understanding how the world works (Keirsey, 1998). These four categories are further broken down per the 16 MBTI types, which Keirsey (1998) characterized exhaustively in his work.

Katy was classified as a Guardian, using the Keirsey Temperament Type Assessment, although her MBTI is ENTJ which would indicate she was a Rational. It is interesting to note that there was discrepancy between the MBTI testing tool, and the Keirsey testing tool. This demonstrates the variability of personality testing, which is a well-documented phenomenon (Geisinger, 2013). Either way, however, as a Guardian or as a Rational, Katy is indicative of the typical engineering personality profile which prioritizes logic, rationality, and authority – traits associated with both Keirsey temperaments. Being identified through the Keirsey tool as a Guardian is also unsurprising, given the focus Katy consistently demonstrated throughout the pilot on being helpful to others, as well as her sense of duty and hard-working nature.

There was a similar discrepancy between MBTI type and Keirsey Temperament with Claire, who tested an INTJ, meaning she would also be a Rational, but whose Keirsey result placed her as a Guardian. Like Katy, that she could be classified in both temperament categories is unsurprising given the nature of engineering education and practice. It was interesting to see her classification as a Guardian, as Claire was clearly concerned with titles and credentialing to represent herself in the workplace, and saw her titles and credentials as an important tool in helping her realize her career goals. Of course, her attraction to the peer mentoring pilot program and seminar course was her corresponding realization that those titles needed to be underpinned by an ability to lead people and overcome her natural tendency towards humility – as well as being helpful to the detriment of her personal goals (i.e. helping colleagues and immediate superiors without ensuring she was recognized for that work by people in positions of authority and the ability to give her promotions). Claire was also typical of the Guardian temperament, as she was focused on security and stability, which was why she had returned to school to pursue engineering in the first place, seeing that as a source of stable and lucrative employment.

Cliff was classified as an Artisan, and was the only mentor whose MBTI type (ESTP) matched his Keirsey Temperament category. Cliff was a typical Artisan, as he had a natural ability with the mechanical and industrial ‘arts’ and was at home in “the world of solid objects that can be made and manipulated” and “with tools, instruments and vehicles of all kinds” (Keirsey Temperament Sorter II, 2015). This was demonstrated by his choice of course to assist, which was centered on the creation of a robot, and by far the most ‘hands-on’ of the first-year engineering courses from which the peer mentors could select. His natural aptitude for designing and building was indicated in his Intake Survey as well. As his MBTI type aligned with his Keirsey Temperament type, it was possible to further classify him per the Keirsey sorter, as an ESTP he was considered a “Promoter” within the Artisan temperament.

A “Promoter” is less interested in routine events, has a low tolerance for authority and commitment, and prefers to live in the moment (Keirsey Temperament Sorter II, 2016). Whether this is an apt characterization of Cliff, is hard to say. He did struggle with his course commitments – both in terms of the seminar class and the practicum component. He was never disrespectful towards me, the curricular peer mentoring pilot program coordinator and seminar course instructor, but it was clear through our interactions that authority was not something that he responded to in the same manner Katy and Claire did.

Another aspect of a “Promoter” is their charm, confidence, and optimism. This makes them popular among their peers and with their superiors. As Katy commented at one point during the seminar course to me that she enjoyed a friendship with Cliff. For my part, I too found Cliff to be a happy addition to the course, livening up the seminar course discussions and bringing a positive attitude to the overall curricular peer mentoring intervention despite the fact that he did not attend to his practicum placement as much as Katy and Claire did.

Big Five Personality Type Assessment

Another popular and widely used assessment tool is the “Big Five Personality Model” or “Five-Factor Model” which describes the human personality traits in terms of five basic factors: openness, conscientiousness, extraversion, agreeableness and neuroticism (Lockenhoff & Costa, 2007). Each of the Big Five traits is a continuum along which an individual's characteristic tendency is located. For example, in terms of extraversion, a person can be on one end of the scale as an extreme extravert, at the other end of the scale as an extreme introvert, or anywhere between. The five-factor model of personality has been found to be valid across an extensive variety of cultures (Anderson, 2013; Goldberg, 1990), as well as gender and age (Lockenhoff & Costa, 2007). Below is a brief overview of each trait:

- People who score high on *neuroticism* are emotionally sensitive and frequently experience negative emotions. They tend to be nervous, moody, insecure, and irritable, and are more likely to be sad, angry, anxious, self-consciousness, and vulnerable to stress. People who score low on *neuroticism* rarely experience negative emotions, and are emotionally stable and calm even in stressful situations (Anderson, 2013).

- *Extraversion* distinguishes between people who are talkative, energetic, and bold and those who are introverted and therefore quiet, shy, and withdrawn. People who score higher on extraversion are more likely to feel comfortable around other people and start conversations, and are comfortable receiving attention. People who score lower on this trait are less talkative, content to stay in the background, and do not enjoy receiving attention (Anderson, 2013).

- People who score high on *openness to experience* are curious, imaginative, have broad interests, and embrace unconventional ideas and values. They tend to be more sensitive to aesthetic experiences and fantasy, and enjoy a rich emotional life. People on the other end of the spectrum experience their emotions less intensely, tend to be more conventional in their outlook and behaviour, and are more likely to be closed to new ideas, activities, and cultures (Lockenhoff & Costa, 2007).

- *Agreeable* people are altruistic, cooperative, compassionate, and trust the good intentions of others, and are more likely to be straightforward, whereas disagreeable people tend to be characterized by antagonism, scepticism, and competition (Lockenhoff & Costa, 2007).

- Finally, *conscientiousness* characterizes people who strive to achieve high standards and are self-disciplined, thorough, responsible, organized, self-disciplined, and scrupulous; the opposite end of the spectrum characterizes people who may be careless and disorganized in personal matters, undisciplined, and unscrupulous (Jia, Zhang, & Zhang, 2015).

An exhaustive body of research has conclusively established the importance of these five personality dimensions to major topics in management, such as job performance, motivation, leadership, teamwork, entrepreneurship, and strategy (Anderson, 2013). Most important this study is how the Big Five relate to leadership, given that was an important theme within the curricular peer mentoring intervention. A well-regarded, comprehensive analysis of seventy-three studies classifying the Big Five personality variables found that *extraversion* is the most consistent predictor of leadership emergence and effectiveness, with *openness* and *conscientious* the other important predictors in determining leadership

	Extraversion	**Agreeableness**	**Conscientiousness**	**Neuroticism**	**Openness**
Katy	33 (average)	20 (relatively low)	45 (relatively high)	29 (relatively high)	23 (relatively low)
Cliff	27 (average)	28 (average)	32 (average)	11 (relatively low)	Not reported
Claire	16 (relatively low)	30 (relatively high)	42 (relatively high)	14 (relatively low)	29 (relatively high)

capacity (Hogan & Hogan, 2004). Below is a breakdown of each mentor`s score:

Table 9: Big Five Factor Scores for Curricular Peer Mentors

As would be expected judging by her MBTI type that concludes she had a 'marginal or no preference' for extraversion over introversion, Katy showed an average score for *extraversion*. At first glance, it seems surprising that she has a relatively low score for agreeableness, given her obvious orientation towards working with people and concern for the welfare of others. However, scoring low in this category makes sense as Katy is a young female engineer, and it is possible her success and persistence in engineering education ability to despite its arguably sexist culture has been due to her tendency to be more aggressive and focus on her own goals and initiatives.

She does, however, score relatively high in *conscientiousness*, which explained her high level or organization, efficiency, and sense of responsibility. Perhaps Katy's concern for others and desire to be a leader in her community is therefore tied into her high levels of conscientiousness – in particular, her high level of responsibility. She is also relatively high in *neuroticism*, which means she is more prone to emotional distress and feelings of insecurity. This was an interesting score, given Katy presented herself as confident and capable. Over the course of the curricular peer mentoring pilot program and seminar course, however, she did demonstrate a higher level of emotional sensitivity becoming stressed during a period of busyness with her extracurricular responsibilities – especially as compared to Cliff who was also occupied with similar extracurricular responsibilities but was decidedly less frazzled by them. That Katy was relatively low in *openness* was also not surprising as she had a practical nature, but in some senses, it was surprising considering her attraction to an engineering specialization that was much more abstract and conceptual.

The Big Five score for Cliff was expected. He was average across all categories, except for his low level of *neuroticism*. His high level of emotional stability was clear from his demeanor throughout the course, as he was unruffled by deadlines, by his other course commitments, or his student leadership activities. He was clearly confident in himself, and not easily frustrated by the pressures of being an overscheduled engineering student. That he had an average score on *conscientiousness* could be construed as unexpected given his lack of follow-through on course requirements, but this is only when compared to the other two mentors.

Both Katy and Claire had relatively high levels of *conscientiousness*, so it is easy to view Cliff's level of industriousness, reliability, and orderliness as subpar, but when compared to the general population his scores are average. As noted in the table above, there was no recorded score for Cliff's level of *openness*. This is unfortunate, because it would be interesting to see if his Artisan temperament would be correlated by a high score for *openness* given those who are more open to experience tend to be excited by new ideas, creative, and artistic. Perhaps, however, he would have had a low score in this personality factor because he was also very practical and hands-on in his approach to work.

Claire's Big Five score was likewise expected, with her strong preference for introversion indicated by her MBTI type being confirmed by her low *extraversion* score; her high and relatively high levels of *agreeableness* and *conscientiousness* respectively was also demonstrated by her cooperative nature and high levels of organization. Her high score for *openness* was in keeping with her artistic temperament as indicated by her intake survey responses, as she was attracted to creative pursuits. Her high level of *agreeableness*, combined with her low levels of *extraversion*, set her up to have difficulties with some aspects of leadership. Being agreeable meant she would be a better leader in some sense because “to gain the acceptance of others, leaders must be sensitive to the needs of followers, concerned, considerate, and generous” (Hogan & Hogan, 2004) – all traits that characterize *agreeableness*.

However, her low levels of *extraversion* meant she would have difficulty achieving status in a group, which requires leaders who are “dominant, expressive, persuasive, and willing to take initiative to get things done” (Hogan & Hogan, 2004) – key traits of *extraversion*. In many ways, Claire’s personality tests underpinned her own self-awareness: she recognized she had difficulties with leading people because she was not comfortable with being the focus of people’s attention. At the same time, however, she also knew if she could negotiate her tendency towards introversion that she had the necessary attributes to be an excellent leader given her above average levels of *consciousness* and *openness*.

In conclusion, the Big Five Factor scores for the mentors indicated that Katy and Cliff would find it easiest to be leaders, as they had average scores for *extraversion*, which was the most important of all five factors in determining what personality trait best corresponded to effective leadership. In terms of *agreeableness* and *conscientiousness*, however, Claire had the upper-hand, as she scored relatively high in both categories. Arguably, it would be easier for Claire to develop a fully rounded leadership skill set, as her awareness of her own introversion as a limitation to her leadership capacity had already led her to proactively address this character trait for signing up for the course. Furthermore, her lack of *neuroticism* meant she had an innate self-confidence and emotional stability that would serve her well when in a leadership position.

Working Style Inventory Assessment

In addition to the MBTI, Keirsey, and Big Five Factor personality tests conducted on the mentors, a small side survey was conducted on their working styles as well. The working style inventory used in this study was adapted from Wilson Learning, an established industry leader in corporate training and publisher of the *Social Styles Handbook: Adapt Your Style to Win Trust* (Wilson, 2011), which based its inventory on research undertaken in the 1964 by organizational psychologist Dr. David Merrill who formulated a personality test that described four patterns of human behaviour and interaction styles (Mulqueen, 2012). This test was deliberately used to profile the mentors as it had been previously used by Professor Karen King in her work with engineering students, and could therefore add to the data set on engineering students at Maple University and/or be used in future surveys or studies of the Maple University engineering cohort. These four working styles outlined by Wilson (2011) are: Driving, Expressive, Amiable, and Analytical. Drivers are assertive, strong-willed, and emotionally controlled. Expressives are people-oriented, animated, and lively. Amiables are people-oriented, relatively unassertive, warm and reliable. Analyticals are task-oriented, unassertive, and cautious. Below is a brief overview of each working style (Leland & Bailey, 2006; Wilson, 2011).

AMIABLE	ANALYTICAL	DRIVEN	EXPRESSIVE
Friendly Good listeners Large friend networks Caring Over sensitive Unassertive Courteous Accommodating Risk-averse	Organized Thoughtful Systematic Logical Factual Problem-solvers Dependable Independent Conservative	Task-oriented Assertive Authoritative Independent Competitive Stubborn Impatient Controlling Decision-makers	People-oriented Assertive Animated Intuitive Excitable Fast-paced Overcommitted Impatient Easily bored and/or distracted

Table 10: Working Styles

Katy was predominately *expressive* and *analytical*, with a strong secondary preference for *driving*. Her score for *amiability* was significantly lower than any of the other three categories. Given her Big Five personality profile, her low level of *amiability* was expected, although again it was out of sync with her intake survey responses wherein she indicated her concerns for the welfare of others, being a community leader, and assisting her peers. Her low level of *amiability* was also discordant with the researcher observations of Katy as a friendly, warm, and approachable person. Again, any reason for this discrepancy between test results and her self-reported survey data or the researcher observations is purely speculative. Claire's, working style inventory scores, however, did reflect Intake Survey responses as well as her results from the previous personality tests she completed. She was principally *amiable* and *analytical*, with lower levels of *drive* and *expressiveness*. None of these results were unanticipated, as her low levels of extraversion validated her low score on *drive and expressiveness*; her high level of *agreeableness* and *conscientiousness* validated her high *amiable* and *analytical* scores. Unfortunately, Cliff did not submit his working style inventory, despite repeated reminders; therefore there is no data point for him on this personality test.

All four of these personality tests, being the Myers-Briggs Type, Keirsey Temperament Sorter, Big Five Factor Personality, and Working Styles Inventory were an important source of data for the study as they provided information on the types of personalities attracted to peer mentoring and leadership roles, and the strengths and weaknesses of certain personality traits in undertaking activities associated with those roles. These tests also helped inform a key assessment piece in the pilot curricular peer mentoring program seminar course: The Leadership Profile.

4.3.3. Leadership Profiles

Being an effective leader was important for the peer mentors during their time within the program, as well as upon graduation. The mentors were the outward face of change when it came to the curricular peer mentoring intervention, and being the face of change requires strong leadership. Teaching leadership skills was also an objective of the course, and was deliberately noted in the course name to attract senior engineering students to the course.

Given the importance all three mentors placed on leadership and the development of their leadership abilities, data collected from the intake surveys and personality tests was combined with observational data on the peer mentors by the researcher was formalized in a two-part course assessment piece around leadership. The first part of the assessment was a midterm review that we held in-person with the mentors as a group, wherein a 'leadership profile' was distributed that was made based on observations of the mentors in the seminar course, as well as their personality tests, their intake survey responses, and their program applications.

Included in each profile was a ‘personal learning goal’ that was set for each mentor individually. The objective of each learning goal was to highlight an area of weakness, and provide an activity to help strengthen against that weakness. The mentors were asked to review their leadership profile for accuracy, and consent to their learning goal. They were informed prior to, during, and after the distribution of their leadership profiles that they were welcome and encouraged to disagree with their assessments. None did, and in fact they were positively surprised at the insight into their personalities, strengths and weaknesses.

The second part of the leadership assessment piece asked them to complete their learning goal and critically reflect on this when writing their own ‘Leadership Philosophy’, which was a piece of reflective writing submitted at the end of term. Therefore, this data point spans both phases of the research program, because it happened at the midpoint and the endpoint of the curricular peer mentoring intervention, and therefore offers an understanding on the evolution of the intervention, which helps assess the impact of the program on the mentors and shows the change process taking place at the level of individual people.

By evaluating how the mentors perceived themselves at the beginning of the term with the intake surveys, it was possible to see their initial perception of themselves and their chosen profession of engineering. Midway through the term, with their leadership profiles and learning goal, I reflected their own thoughts about themselves from the beginning of the term back to them and asked them to consider whether they had changed at all. These profiles and goals were based on my observations of the mentors up until that point, and in combination with my analysis of their personality tests.

The profiles highlighted for the mentors how they had already changed, but also what other changes they could make to further align their current selves with their perceived selves. The mentors could take this information forward, working on their personal learning goal for the remainder of the term, and critically reflecting on that in their final leadership philosophy, which asked them to evaluate their own individual change over the duration of the pilot program. Each mentor leadership profile and personal learning goal is annotated below:

Katy

Katy is a high-functioning individual, who readily takes on challenges and opportunities pertaining to leadership. She is driven to be successful beyond the basic requirements of her engineering degree, and has taken on various responsibilities throughout her program. Throughout her studies she has pursued extra-curricular activities.

Katy enjoys being busy, and lives a highly-scheduled life wherein she is responsible for various activities and outcomes pertaining to her extra-curricular activities. She is quick to see opportunities and works hard to realize these opportunities. The ability to utilize her abilities and have positive interactions with her peers has significantly influenced her persistence in her program, as her extra-curricular work shows. This has also given her the opportunity to develop close relationships *with the engineering faculty and administration, which has also been an important factor in her education.*

Katy is an extrovert who likes to communicate with people, and readily shares her enthusiasm for engineering with her classmates, as well as her community. She is approachable, energetic, and affirming towards others. Her inclination to occupy leadership roles is an expression of her innate disposition, which can be characterized by her continual pursuit of improvement and achievement. This constant push to realize her vision(s) is supported by her actions, as she is highly-organized in her approach to achieving her goals and makes comprehensive plans to guide the pursuit of her goals.

Katy identifies strongly with her province of origin, living there her entire life. She also identifies as Indigenous, and part of a First Nations band. She decided to study engineering upon leaving high school because of the joy of science she discovered through her chemistry teacher, plus she was attracted to the challenge of the curriculum and felt she had the skills needed to meet those challenges. Engineering also offered her the opportunity to secure a well-paying job upon graduating, while still using her education as means to address social problems. As she leaves her program in process engineering, she is keen to work in industry, but also has a desire to participate in a business start-up and/or purse her MBA.

Securing a well-paying job through her degree, or possibly returning to school to obtain an MBA or running her own business successfully will likely help Katy realize her personal goals of raising a family and helping others in difficulty. It *would also enable her to better actualize her professional goals of having formal positions of leadership in her career, and leading important workplace sustainability and social responsibility initiatives. As someone who deftly manages her time, her personal desire to engage in volunteer work in her community is something she will likely be able to accommodate in her schedule regardless of the demands her professional goals place on her schedule.*

Personal Learning Goal:

Katy is clearly highly-capable, organized, and efficient in accomplishing her goals. She is also a natural leader, and has participated in various activities that have further honed her natural leadership abilities. One area that Katy has identified, however, as a source of concern is her writing skills. If she wants to occupy formal leadership positions – particularly engineering management positions – it will useful for her to develop her professional writing skills.

As her strengths as a driver and an extravert are already established, working on her writing skills offers more than a concrete outcome (i.e. improved writing style) if they are developed through peer-to-peer or instructor-student feedback. This will help offset her relatively low scores of agreeableness and amiability by forcing her to work with others in a non-leadership role, and more importantly it will mitigate the tendency towards neuroticism (i.e. negative thinking) that she can experience by asking her to positively embrace an area of weakness.

Katy would therefore benefit from using her writing assignments in this course as opportunities to workshop her writing approach with the instructor and/or her classmates.

Cliff

Throughout his program, Cliff has pursued extra-curricular activities within the engineering faculty. These experiences will not only help him realize some of his professional goals upon graduating, but also demonstrate the importance that Cliff places on volunteering and community.

Cliff identifies strongly with his province of origin, and chose to study for his engineering degree at a university in the province upon leaving high school. He was attracted to engineering because he liked the challenge the curriculum offered, but also felt he had the ability to meet those challenges as he is good at math and science. Furthermore, he had participated in a previous engineering workshop for high school students that solidified his choice. Cliff also saw engineering as a good route to a well-paying job. Once he graduates he intends to work in the engineering industry and/or possibly pursue an MBA.

Obtaining an MBA would likely help him realize his desire to have formal leadership roles in the workplace, as well as be financially well-off. One thing that is very clear from the topics that interest Cliff is how his desire to be financially successful would allow him more readily appreciate the sustainability initiatives that interest him. With an MBA he may be able to pursue that personal objective in the workplace to through formal leadership initiatives, or even his own business *ventures. Financial success and/or management roles would likely also support his personal goal of raising a family.*

Although Cliff has a clear desire to be a successful leader and professional, his love of science and engineering for its own sake is obvious. He is excited by the possibilities that his particular field – mechanical engineering – can offer for the future, as well as the general possibilities that engineering offers for discovery and development. This seems to be a deeply ingrained character trait, as Cliff indicates that his love of learning how things work has always been a key source of interest and joy in his life. He realized this enthusiasm for figuring out how things work could be a career path when his interest in physics led him to engineering.

Personal Learning Goal:

Cliff is a fairly well-rounded person, with little tendency to neuroticism and a balanced level of agreeableness, consciousness, openness, and extraversion. Therefore, the personal goals for Cliff to pursue have less to do with balancing his personality traits and/or helping him mitigate some of the negative effects an overabundance of a certain trait might have. Instead, Cliff should focus on building his leadership skills by working on his follow-through on commitments and responsibilities he undertakes. Having a more reliable follow-through strategy will position Cliff to develop the organizational skills necessary for him to realize his goals of being a formal leader or manager in the workplace.

Claire

Claire identifies strongly with her province or origin, and chose to remain in the *province to pursue her university education. She has a previous undergraduate degree, holding a Bachelor in a social sciences discipline. She currently works in the construction industry during her engineering work terms, and has also worked full-time prior to taking the engineering program.*

Claire has an entrepreneurial spirit, and is interested in starting her own business or being part of a start-up business in some capacity, while still working in the engineering industry. Her interest in sustainability and corporate responsibility suggests these elements would feature in any start-ups she had the opportunity to begin or participate in.

Claire realizes that developing her leadership skills is an important goal to achieving her entrepreneurial ambitions, but will also help enable her to actualize her other goals of being a project manager in her field and pursuing a career in engineering management in general if those opportunities come more readily for her. Although she was attracted to engineering because of the challenges it offers, she also appreciates the ability for her to have a well-paying job when she graduates her engineering program. Therefore, her focus on management in the engineering field is not only important to her professionally and financially, but is also important to her personally, as it allows her to pursue her personal goals of having a stable home life with her partner and raising a family.

Although Claire is technically competent and interested in the challenges engineering offers, she also nurtures the artistic aspect of her nature by painting, cross-stitching, quilting, etc. although this is something that clearly brings her *personal satisfaction as she does not find it important to seek formal recognition of her artistic works.*

In terms of her decision to return to school to pursue and continue her engineering degree, Claire identifies the support and encouragement of her family, as well as the opportunity for financial aid and scholarships as a significant factor influencing her return. The effective environment and experience of her engineering education has also influenced her to persist in her education, as has her achieving a level of performance satisfactory to her and enjoying good teaching and teachers throughout her education.

When asked to think about what has helped develop her identity as an engineer, Claire speaks affectionately about the impact of her grandfather – a civil engineer – who would take her to work with him and teach her about his job, and how things were made and built. It is clear that her description of him as a competent engineer, and a socially-conscious and community-oriented person, has impacted her understanding of her profession and the goals she wishes to pursue through her career choice.

Personal Learning Goal:

Claire has indicated her desire to develop her leadership skills is a strong motivator for her to take the pilot course, while acknowledging that public speaking can be a source of discomfort. Therefore, I suggested that Claire present a problem set in her host course to the students in the class, under the guidance of her host instructor, Instructor 2.

This is an appropriate goal for Claire, as her working style is predominantly amiable and analytical, which means she already has a good temperament for working with others and is suited to the expectations and demands of her career field. These results are supported by her relatively high scores of agreeableness and conscientiousness and openness.

She could benefit, however, from developing aspects of the driver working style to help reach her professional goals of being a formal project leader and/or manager. By being responsible for presenting a problem set in her host course she will be required to negotiate her tendency towards introversion and develop more comfort occupying positions of formal leadership.

Reporting on the mentor's response to their Personal Learning Goals as given above and the subsequent development of their 'Leadership Philosophy' is discussed in the next chapter. Furthermore, although most of their respective Leadership Profiles were based on the intake survey data and personality tests returned by the mentors, they were also informed by the researcher's observations of the mentors. These observations also provide insight into some of the barriers to being effective curricular peer mentors faced by Katy, Cliff, and Claire. These barriers include their personality type, the constraints of the first-year engineering program, as well as the larger institutional resistance to, and/or uncertainty with, change.

The significance of these numerous personality tests, and the development of the peer mentoring leadership profiles and personal learning goals, was multifaceted. First, it was to support individual change among the mentors themselves, to help them in their own learning and personal growth. Second, it was to capture an in-depth profile of what types of personalities were attracted to peer mentoring, and what types of personality traits supported curricular peer mentoring. Third, it was to assess how change happens at the individual level, and whether individuals could promote change among their communities.

4.3.4 Mentors in Action: Researcher Observations

Prior to the course commencing, the mentors were asked to select their host course from the first-year courses identified by Professor Jackson as requiring additional support. As previously discussed in Chapter 3: Methodology, the conditions of implementing the pilot curricular peer mentoring program in engineering was that it be used in their 'high-risk' first-year engineering courses. There were also structural constraints preventing the pilot from operating in other courses given the inflexible nature of the engineering program structure. Therefore, the mentors were restricted in their choice of host course and host instructor[57]. This was unfortunate, as regardless of the model used, mentorship programs work best when the mentors have full control over their mentoring practice (i.e. what they mentor, who they mentor) (Smith, 2013). This was a concern I had raised with Professor Jackson as we worked to develop the program, but due to the constraints he was working under (limited faculty support, a restrictive program structure, and administrative

[57] This restriction was discussed by the mentors throughout the term and they spoke to it at length during the group interview. I did not prompt this discussion, and had been clear with them about the reason for the restriction. They recognized of their own volition the negative impact this had on the mentoring practicum and were simultaneously excited about the possibilities of mentoring in an engineering course of their choice. They raised this issue in a meeting at the end of term with Professor Jackson and Dr. Wessel, who had asked for their feedback on the first-year engineering experience and the overall functioning of the engineering program.

anxieties about certain first-year courses) we agreed that the curricular peer mentoring pilot I was familiar had to be adapted to fit the faculty of engineering context.

The mentors were therefore only able to select their host course from ENGI A, ENGI B, or ENGI C. There was only one class offered in ENGI A and ENGI B, taught by Instructor 2 and Instructor 3 respectively. There were two classes offered in ENGI C, but both sections were team-taught between Instructors 1 and 4, so choosing either course would still mean having both as host instructors. Katy chose to work with Instructor 3 in ENGI B, Claire chose to work in ENGI A with Instructor 2, and Cliff worked with Instructors 1 and 4 in ENGI C.

Over the course of the seminar course and practicum placement the mentors demonstrated differing levels of engagement with the course materials and the mentoring practicum. It is not possible to say how influential the restrictive practicum placement had on their engagement with the program, as other barriers to fully engaging with the program were present. These barriers included the intense workload of their senior engineering courses, the involvement of some of the mentors with demanding extracurricular responsibilities, the involvement of one mentor in a year-long internship with a professional engineering company, the attitudes of the host instructors to hosting a curricular peer mentor in their course, and the attitude that the mentors themselves brought to the program.

Katy

It was clear that Katy was committed to the peer mentoring pilot, which was as likely a product of her natural inclination to involve herself with her community and her desire to uphold her ‘A’ level scholastic performance, as much as it was due to her support for the peer mentoring concept. At the beginning of the term I had asked the mentors to submit a 'Semester Plan' that outlined their schedule and associated mentoring duties. Katy set a weekly schedule with activities planned for each week of the semester, including the time she would spend in the seminar course, the time she would spend undertaking the seminar course work, the time she would spend in the host course lectures, the time she would spend in the host course tutorials, the time she would spend on providing additional help to the host course students, as well as a weekly update with her host course instructor. Not only did she adhere to this plan, she also prepared notes alongside each weekly activity listed in her semester plan to further organize and direct her mentoring activities. This level of organization and planning is in keeping with her MBTI personality type, and aligns with the data collected from her Intake Survey.

One of the reasons that Katy was exceptional as a mentor can be attributed to her attitude as discussed above, but also the attitude of her host instructor. Katy was placed with the youngest host instructor, Instructor 3, a junior academic at Maple University. He was eager to explore teaching and learning innovations, and was interested in the program and its potential. Instructor 3's openness to new teaching and learning methods made him the ideal host instructor for the peer mentoring pilot. He did not already have an established teaching practice that he was being asked to adjust, and he was keen to experiment with different teaching methods.

Therefore, Katy and Instructor 3 were the model pairing of peer mentor and host instructor. Despite this, there were still barriers to the best functioning of the peer mentoring intervention. One of these barriers was the way the mentor-host course pairing was structured. There were over 150 students enrolled in Instructor 3's course, and Katy was the only mentor in the course. The course met three times a week for 50-minute lectures *en masse*. There were then three additional tutorial sessions every week as well, which hosted 55 students. Clearly, it would be impossible for Katy, a full-time engineering undergraduate with a full course load and additional extracurricular responsibilities to be present at all, most, or even some of these 6 weekly in-class sessions with students.

Another barrier was the misconceptions that the host instructor had about the mentoring role and responsibilities. Instructor 3 began to treat Katy as one of a paid graduate assistant as the term progressed, despite it being communicated clearly at the introductory meeting that the peer mentors were not there to 'work' in the sense they were not paid, or required to work to a set schedule or a set number of hours each week. Although it was useful and valuable that Instructor 3 welcomed Katy onto the teaching team, he began to rely on Katy to fulfill functions above and beyond her role as a mentor (i.e. preparing teaching materials at his request instead of her discretion, and spending large amounts of time helping students with their projects in the course tutorial sessions). Given his approachable manner, however, Katy could speak to him about being overtaxed by his expectations of her. Therefore, the issue was resolved amicably.

This mismatch between Katy and Instructor 3 about the role and responsibilities of a peer mentor would likely be an initial barrier to the optimal functioning of any curricular peer mentoring program. It is a complicated pedagogical intervention, wherein an entirely new role has been created (curricular peer mentor) to operate in university classrooms that have set roles (course instructor, teaching assistants). The peer mentor role, as discussed in Chapter 2: Literature Review can take various formats, and the specific format being used at Maple University was less familiar to the program participants – mentors and host instructors alike – because it was neither a paid nor a volunteer position and the peer mentoring role was not tightly structured with set roles and responsibilities. Therefore, it was not surprising that the peer mentoring role was negotiated on an *ad hoc* basis during the curricular peer mentoring pilot program and seminar course, and in further iterations of the program it would likely happen again. Retaining the flexibility of the peer mentoring role is a valuable component of the program, however, as it allows the peer mentoring intervention to be responsive to specific classroom settings and/or host instructor needs. Thus, the deliberate openness of the peer mentoring role might be a barrier at first, but in the right circumstances (i.e. an approachable host instructor paired with an assertive peer mentor) this barrier can be easily overcome.

Cliff

The relationship between the peer mentor and the host instructor(s) is crucial to the best functioning of the peer mentoring intervention. With Cliff, the main barrier to the functioning of the pilot peer mentoring program was not with his host instructor relationship, or with a mismatch of expectations between both parties. It was with how Cliff applied himself to the practicum component of the pilot program that created a barrier to its best functioning, as Cliff did not commit as much time to the pilot program as the other two peer mentors.

Cliff chose to mentor in the largest first-year engineering course, which had two host instructors, each of them responsible for lecturing two course sections enrolling approximately 200 students respectively. In addition to the three weekly 50-minute seminars, there were 6 separate tutorials enrolling approximately 30 students. Therefore, Cliff faced the same barrier that Katy did to be an effective mentor for such a large group of students. However, Cliff's response was to be less involved in the practicum component.

He was late the day he was to introduce himself to his host and his attendance was sporadic from there on. Like Katy, he was occupied with his extracurricular activities. He verbalised these responsibilities as a reason to excuse himself from the peer mentoring practicum – as well as from submitting the seminar course assignments on time. To address the time constraints of all three mentors, the course assignment submission dates were reviewed at the beginning of term and throughout the term to help all mentors met the assignment deadlines. Furthermore, the course schedule was updated at numerous points to accommodate Katy and Cliff and their extracurricular activities.

Although Instructors 1 and 4 were both open to the curricular peer mentoring intervention and hosting a peer mentor in their respective course sections, they were not actively engaged in the process to regularly contact Cliff or request his assistance. Cliff's personality tests - MBTI and Keirsey types - characterized him as being impulsive, resistant to schedule and routine, and having a desire for action and adventure. This was a character trait that he was aware of, acknowledged and had a desire to address.

Claire

The opposite peer mentor-host instructor situation characterized Claire's experience. She was committed to the peer mentoring practicum, but was paired with a host instructor that chose not to participate in the pilot program in a meaningful way. Claire was placed with Instructor 2, who was responsible for a class of approximately 175 students that met three times a week for a 50-minute lecture. There were only two tutorials each week, with the students evenly split between both tutorial timeslots. This meant there was a lot of opportunity for Claire to mentor, as the tutorial sections were the largest of the three first-year engineering courses, hosting half of the students per tutorial.

Having an additional person for the students to speak to about the course concepts and assignments would have been even more beneficial in Instructor 2's class than the other first-year courses not only due to the crowded tutorial sessions, but because he also taught some of the hardest subject matter. This is perhaps best demonstrated by the failure rates for each host course: The ENGI C classes historically taught by Instructor 2 have the highest failure rate among the three first-year host courses with 34% of students failing, as compared to 26% in Instructor 3's course and 23% in the course taught by Instructors 1 and 4.

What made this peer mentor – host instructor relationship more difficult was the fact that Claire was the archetypal introvert and the regular activities of acting as a peer mentor were already a challenge for her given her acknowledged difficulties with being assertive in school and work situations. The typical peer mentoring activities would ask her to introduce herself to the entire class of approximately 175 students at the beginning of term, to take the initiative in organizing student meet-ups, hosting study sessions, communicating via email or social media platforms, and coordinating her activities with the host instructor.

Her natural reserved personality may not have been a barrier to the best functioning of the peer mentoring practicum if she was paired with a different host instructor, as she reported feeling intimidated by Instructor 2, finding he either ignored her or interfered in her mentoring activities. This impeded her personal leadership development goals – as well as the larger objectives of the curricular peer mentoring intervention. This pairing of peer-mentor and host provides an interesting layer to peer-mentoring and change because it illustrates the barriers and levels of resistance that are possible.

Mentors in Action: Concluding Thoughts

In summary, each of the three mentors experienced markedly different practicum placements in their host courses. Katy had the best possible experience considering the larger constraints surrounding the curricular peer mentoring intervention, which required the peer mentors to mentor in set courses and with set host instructors, serving 150+ students alone. She was fortunate to be paired with an open-minded host instructor who wanted to work with her and the program. Cliff could have had a similarly positive experience as his host instructors were interested in the program, but needed to be actively engaged by the mentor. However, this would have required that he proactively approach the host instructors and the host course students to make the practicum placement effective. Claire did not have a positive experience because she was paired with a host instructor whom she found intimidating, and who chose not to meaningfully engage with the pilot peer mentoring program.

The personality tests conducted at the beginning of the term help to partly explain why some mentors excelled in their role, whereas others struggled. Given the level of personal commitment required to be an effective mentor, and the requirement to work with others, I hypothesized that the personality types best suited to being effective mentors would be those which featured high levels of self-sufficiency (conscientiousness), while still having an outgoing nature and desire to work with others (extraversion). The personality test results returned from Katy supported this hypothesis, as she was *extraverted* (MBTI), was a dependable *guardian* (Kiersey Temperament Sorter), had high levels of *conscientiousness* (Big Five Factor), and was *expressive* and *driven* (Working Style Inventory).

Cliff was an extravert, but not notably conscientious (according to the Big Five Personality Test), which showed in his uneven mentoring practice. Although he was rarely absent from class, and he actively contributed to the PAR Workshop presentation to first-year engineers[58], he was less consistent in the day-to-day, individual mentoring responsibilities of attending host course classes and labs, reaching out to the students in his host course, or initiating meetings with his host instructors. It seems that being an extravert is only one trait of an effective mentor, and alone it is not enough to support a successful mentoring practice.

[58] PAR Workshop Presentation Outline indicating each mentor's participation is available in APPENDIX T

This is an encouraging observation, as extraverted Katy and Cliff are not typical of the predominant engineering personality types because engineering often attracts introverts (Bannerot, 2009; Rosati, 1997). This would make it more likely that a curricular peer mentoring program instituted in an engineering program would have introverted mentors simply due to the personality traits among engineers. Therefore, it is important to evaluate whether introverted personality types can be effective mentors. It was possible to examine this question through Claire, who was an introvert. Although introverted, Claire was still highly conscientious and participated as fully as possible in the program despite the difficulties she experienced with her host instructor. She initiated her own student outreach through a Facebook group, attended her host course classes and labs, and attempted to work with her host instructor.

I had hypothesized that conscientiousness would be a key personality trait in an effective mentor, as mentors must be intrinsically motivated to fulfill the responsibilities of the role. This hypothesis was therefore proven correct, as a key difference between Katy and Cliff was their levels of conscientiousness. Cliff was not highly conscientious like Katy or Claire, and he did not consistently follow through on his responsibilities as a mentor – something he realized in his own personal reflection on the program.

Regardless, engaging effectively in the practicum placement was difficult for all three mentors for reasons extending beyond their personality type, host instructor relationship, or the structural constraints within the first-year engineering program. The newness of the curricular peer mentoring concept to the student mentors, host instructors, and the students within the host courses, challenged all stakeholders to understand and utilize the intervention. The newness of the intervention was also complicated by its philosophical foundation, as it was a humanities and social sciences based program running in a hard science context. Essentially, the intervention was asking the mentors and host instructors to change their individual thought and behavior regarding their traditional roles as students/teachers in the general sense, and specifically as engineering students/engineering academics. The intervention was also pushing against an institutional stasis by introducing a new course that subverted – on a small scale – the tightly controlled engineering program and its established standard of education provision.

4.4 Chapter Summary

Phase I: Intervention provided insight on the process of institutional change by documenting the journey towards establishing a new university program initiative and undergraduate course at an administrative level. The results of the document analysis conducted on email correspondences, in combination with research observations, suggest that institutional change in a university is difficult given their organizational structure and culture. There are bureaucratic barriers that must be overcome before a change can be implemented. These barriers cannot be surpassed by someone who is not recognized as an authority within the relevant administrative sphere in which the proposed change is to take place. Once it is officially endorsed and implemented by the relevant university administrative body, as negotiated by and promoted by a respected change champion, it must contend either with a culture of unawareness about change, or with a culture of resistance, among academics who are either uninterested in, or resistant to, changing their professional practice.

Phase 1: Intervention also provided insight into the implementation and delivery of a new university program and course from the perspective of those it directly affected, by extensively profiling the undergraduate students (peer mentors Katy, Cliff, and Claire) who applied to the curricular peer mentoring program. The data suggests that they type of people who are more likely to apply to the program are people who are extraverts and/or desire to develop extraverted qualities such as being outgoing, confident, and comfortable with leading people. The mentor profiles, which were established through intake surveys, personality tests, and researcher observations, suggest that effective mentors must be conscientious, and pose questions about the importance of other personality traits, such as higher levels of extraversion and lower levels of agreeableness and amiableness, in supporting mentoring efficacy.

Additionally, this chapter examined the initial responses from the host instructors, which were the faculty members directly affected by the program, detailing their different responses to change. Again, this data point confirms that people have varied responses to change, ranging from supportive to resistant. Observational data also suggests that for change initiatives to be seriously considered by academics, it must first have the backing of a respected and/or more powerful authority, and have been officially vetted. Even this, however, does not overcome resistance to change – it only validates the proposal for change. Furthermore, at a broad level, the data shows how the program was set up to be as successful as possible.

First, the seminar course content and assignments demonstrated an effective model for facilitating change – the people making the change were not being forced to make it, and they were being appropriately supported in making that change, and they also understood why that change was being asked of them (Carter, 2013). Second, every aspect of the curricular peer mentoring intervention was thought about, formulated, and delivered with this in mind. From the first negotiations with the engineering faculty about implementing the pilot peer mentoring program which sought to ensure the program was developed to be successful despite the institutional constraints it had to operate within, to the initial program application that was clear about the program being a change initiative; to the introductory meeting event that was designed to inform the program participants about the program's change goals and attempted to encourage their participation; to the design of the seminar course and the careful scaffolding of the course readings and assignments to build the mentors' confidence in meeting and understanding the course learning outcomes; and finally, in the strategy I took when communicating with the various program participants to mitigate their response to change as threatening and/or unimportant, by being prepared and positive in my communications with all parties.

In the next chapter, Phase II: Assessment, the impact of the intervention is examined through survey responses from students enrolled in the host courses, interviews held with the host instructors, a group interview held with the curricular peer mentors, an interview held with the key administrative stakeholder, observational data gained from a meeting held between the mentors and the key administrators, and a final analysis of the peer mentoring activities and course assessments.

CHAPTER 5: Data Analysis: Phase II

5.1 Introduction

The second phase of data collection helped assess the impact of the intervention in terms of its larger goal of institutional change, as well as the pedagogical goals embedded within the pilot curricular peer mentoring program. There were three major research goals in this phase: understanding the curricular peer mentor experience of the pilot course and peer mentoring practicum; understanding the mentee experience, and; investigating the institutional change process as engendered by the curricular peer mentoring intervention.

With each of these three research goals there were various data collection activities. In terms of understanding the mentor experience, their leadership profiles and personal learning goal activities were revisited, observations of the mentors were made during the workshop they hosted for the student mentees, and a group interview was held with them at the end of term. Revisiting the leadership profiles and associated learning goal at the end of term provided valuable information on the arc of the mentor experience as it spanned across the course. The PAR workshop the mentors hosted for their student peers provided insight into the relevance of the program to the students, and was also a good opportunity to collect further observational data on the mentors[59]. The end-of-term group interview held with the mentors provided valuable data on the effectiveness of the intervention from an 'on-the-ground' perspective; it also allowed the mentors to speak to their perspective of the engineering program at Maple University in general.

[59] PAR Workshop Presentation Outline with presentation topics is available in APPENDIX T.

To understand the student mentee experience, data was collected from the student survey administered within all three host courses. The survey data was extensive, asking the student mentees a comprehensive set of questions to interrogate their impressions of, and interactions with, the curricular peer mentoring intervention. These responses were analyzed to better understand the student mentee population and their educational experience. Their responses were also examined to characterize the host course environment, and the larger institutional culture within the first-year engineering program.

As the table below shows, to investigate the impact that the intervention had in terms of institutional change, surveys were distributed to engineering staff and faculty, and interviews were held with the host instructors and the senior administrator. The staff and faculty surveys were intended to probe whether the larger engineering staff and faculty members were aware of the program, and if so, their opinions about it. The interviews with the host instructors provided a perspective on the program from the important angle of their position: incorporating curricular peer mentors into their courses. The interview with the senior administrator gave a high-level, institutional understanding of the curricular peer mentoring intervention. This was invaluable in investigating the institutional change process, the overall efficacy of the intervention, and the possibilities for future change within the engineering faculty.

5.2. Understanding the Peer Mentor Experience

	Research Goals	Data Collection Activities
Phase 2: Assessment	Understand the peer mentors and their experience of the pilot course and peer mentoring practicum	(1) Leadership profiles of mentors Observations of mentors Interviews with mentors
	Understand the student mentee experience of the peer mentorship intervention	(2) Survey student mentees Collect attrition and GPA rates on students in host course (before peer mentorship intervention and after)
	Investigate the efficacy of the pilot course intervention as a vehicle for institutional change in the case study site	(3) Survey of faculty staff (academic and non-academic) on peer mentorship intervention Interview host instructors and key administrators about their experience of the peer mentorship intervention

Table 11: Phase II: Assessment Research Goals & Data Collection Activities

In the previous data chapter, the curricular peer mentors were analyzed in relation to the intervention of the pilot peer mentoring program. Therefore, their initial applications to the program, the surveys and personality tests they completed when entering the program and the initial observational data gathered on their activities at the beginning of the course were helpful in characterizing the intervention. In this chapter, the further observations made of the mentors, the continuation of their course work in terms of their leadership profiles and individualized learning goals, and their responses to the end-of-term interview questions and written reflection about their experience within the program, help in assessing the impact of that intervention. It is crucial that the mentor experience be examined across both phases of the research project as they are the hub around which the other research populations within the curricular peer mentoring intervention were connected. The diagram below is a visualization of how the different research populations interact with the peer mentors:

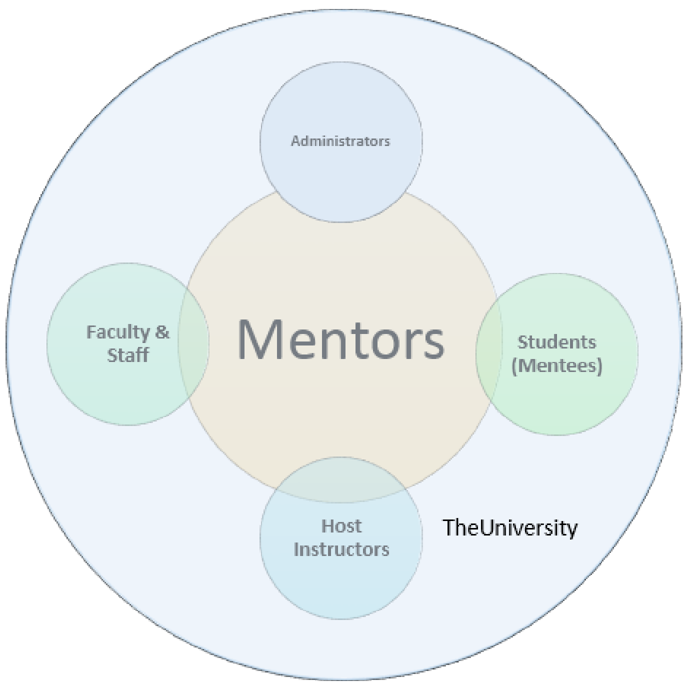


Figure 6: Visualization of Research Populations

By centering the data analysis on the mentors, data obtained from the other research populations can be understood through their response to the crux of the program activity: curricular peer mentoring. The experience of the mentors was examined through four data points. The first data point analyzed their response to their unique “Growth Challenge”, which was a personal learning goal that was assigned to each mentor as part of their leadership profile. The second data point was an analysis of their “Leadership Philosophy”, which was a piece of reflective writing that the mentors submitted in partial fulfillment of the course requirements at the end of the term. The third data point was a participatory action research (PAR) project they undertook as part of their course, which was a workshop they hosted for the junior peers about how to succeed as an engineering undergraduate student. The fourth data point was an end-of-term group interview and a written summary of the mentors submitted of their experience. Each of these data points is outlined in the table below, and explored throughout the following sections on the Peer Mentor Experience:

	Data Point 1	**Data Point 2**	**Data Point 3**	**Data Point 4**
Peer Mentor Experience	Growth Challenge The follow-up activity to the mid-term leadership profile distributed to each mentor based on the mentor intake survey responses, personality test results, and researcher observations.	Leadership Philosophy The critical reflection submitted at the end of term by the curricular peer mentors, reflecting about the progress they made on their growth challenge and the overall changes they experienced during the program.	PAR Workshop The participatory action research project that had the mentors organize a workshop for first-year engineers to provide advice and information on the engineering program and how to enter the profession.	Group Interview & Written Summary The end-of-term data collected from the mentors that evaluated their experience through a group interview at the end of the term and a written summary of their experience.

Table 12: Data Points about the Peer Mentor Experience

A key element of the specific curricular peer mentoring pedagogy employed in this research program was the formation of a “Practicum Portfolio” which was a collection of all the course assignments completed by the mentors, a record of their mentoring activities, as well as their correspondences with students in the host course and the host instructors. The specific documents required in the portfolio were the ***semester plan***, *all three* ***critical reflections,*** *a response to their unique* **individualized learning goal** *or* ***"growth challenge"***, *their* **leadership philosophy,** *all* **digital records of communications** *they had with the host course students and host instructors, and a short* ***summary of their experience*** *as a curricular peer mentor and as a participant in the pilot program.*

Within this Practicum Portfolio was the two-part 'Leadership Philosophy' assessment piece. The first part of this assessment was profiled in the previous chapter, and was comprised of a profile made of each mentor by the research, as well as their individual learning goal. The second part of this assessment was their 'Leadership Profile', which was a piece of reflective writing that they submitted at the end of term after finishing their practicum placement and completing their learning goals. This was submitted in addition to a short, targeted response to their growth challenge[60].

5.2.1. Peer Mentor Experience: Personal Learning Goal or 'Growth Challenge'

The critical reflection about leadership that the mentors submitted was a response to their personal learning goal or growth challenge, which impacted their general development as leaders through their mentoring practicum and in response to the course readings and discussions that took place throughout the term. The growth challenge was a short reflection of 1000-1500 words that asked mentors to reflect on their individual challenge and answer the following questions:

[60] To better highlight this assessment piece was more than a learning activity, and instead mainly a personal development challenge, the personal learning goal was became referred to as a 'growth challenge'.

- What was your challenge?
- Did you think this was a useful/appropriate challenge?
- Did you act on your challenge?
- If so, what did you learn or experience undertaking your challenge?
- How, if at all, did undertaking your challenge help you grow as an engineer/leader/person?

The responses from the mentors are insightful, demonstrating a change process taking place on an individual level, and showing the amount of dedicated reflection that is required to identify how to make a change. It is also useful to realize how change is something that is not often actively pursued, even when a person is aware a change might be necessary, and that it can require external prompting and support to execute a change. This understanding of change at the individual level as viewed through the mentors and their growth challenge assignment is reflected at the institutional level as well, which will be discussed later in this chapter. Their responses to the challenge are discussed below.

KATY

Katy's growth challenge was to further develop her writing skills through a peer feedback session led by the seminar course instructor, or one-on-one feedback session with the seminar course instructor only. She was given the option to work with the instructor only, or the other two mentors as well as the instructor in a group feedback session. She chose to work with the entire group, and in doing so realized the indirect objective of also working on personality traits that might not serve her in a work environment, such as her tendency to be highly self-critical (a trait associated with neuroticism).

Katy recognized this, saying:

"*My growth challenge originally began with only one goal in mind, to further develop my writing skills. However, through the process I also was given the opportunity to work on my vulnerability as well… I cannot think of a better challenge to suit the end goal I sought for. This allowed for me to address two areas in which I feel I should improve on. As an engineer, I naturally do not enjoy writing. I do however understand that writing is an essential communication skill that every professional must use. I am also a person dominated by my emotions; this often leads me to avoid situations in which I am vulnerable to other people's opinions."*

She went on to talk about the emotional aspect of participating in an intentional change process, discussing change as a deliberate movement away from an established routine or habitual behaviours, and also a decision that you can choose to make or not, which is best facilitated when a person is committed to that change (Strydom, et al., 2004). Katy says about change:

"*Although this was a difficult challenge for me to overcome emotionally, I did embrace it. I believe people can only learn if they are thrust out of their comfort zone and I try to live my life in this way, by accepting challenges that I know will test me. It was an interesting way of approaching these two areas of improvement. I enjoyed learning about how everyone read and understood the message I was conveying in my reflection. By hearing the different opinions and comments it has helped me to understand how to properly cater my writing to the appropriate audience."*

Her comments above also suggest the benefits change brings to the person changing, and how it enables new perspectives and new understandings of oneself and others. She continues this train of thought, saying "*I feel that I've learned a lot about the thought process of different types of people. This is an additional, surprise benefit from the exercise that I was not expecting. This experience has broadened my spectrum of understanding when it comes to communicating with people outside of my profession.*"

CLIFF

In his reflection, Cliff recognizes the importance of his growth challenge, and specifically notes as Katy did, that he was aware that the challenge set to him highlighted an issue he needed to address. This issue was his troubles following through on his commitments. About this personality trait he says:

"*I have seen this as a flaw in myself/my work before but was not really sure how to combat/move past it. Upon it being brought forward to me by someone else I realized it was time to really take a stab at fighting this.*"

Again, it is interesting to note that without the external prompts set up by the peer mentoring project, Cliff was not motivated to make the changes that he knew he would benefit from making. This is insightful because it indicates the value of the structured (but flexible) educational process the mentors undergo. Cliff highlights his engineering training - he is logical and methodological – when he continues by saying,

"As with most complex problems there is no simple quick fix, so I had to try and break this down into smaller objectives that in the end would help bring me towards completing

the challenge. After some thought I determined that the biggest part of this solution would be organization, which can be further broken down into two categories; time management and thought preparation."

He discusses his strategy further, noting the importance of advance preparation, agenda-setting, and keeping meeting notes. He also connects this realization about organizing his thoughts to be outside of himself, realizing that by being prepared he makes it easier for others to work with him,

"*Often times when I spend a lot of time working on a project or problem I will forget about the initial assumptions or more simple items when I go to talk to someone else about it. I have found that writing down these assumptions has allowed the person I am meeting with, to much more easily get up to speed with me so that we can discuss specifics."*

Although Cliff did not seem to make significant progress with some aspects of this growth challenge, still submitting his Practicum Portfolio a week late, and being uneven in his understanding and preparation of his work, it is clear that he recognized and was making changes to help himself in dealing with these aspects of his personality.

CLAIRE

Like Katy and Cliff, Claire also recognized her growth challenge as highlighting a personal limitation, being her tendency to let her natural introversion hold her back from taking on leadership roles as being a leader often entails being visible. She identified with her assessment as an ISTJ and the leadership profile she was presented with during the mid-term review, and agreed that her growth challenge was appropriate – although difficult. She was initially set with the task of presenting a ‘problem set’, which is an engineering curriculum tool wherein students are given a series of problems to solve and must document their solution step-by-step, within her host course to the students in the class. She was unable to present to the host course, and therefore presented to the students in the PAR workshop that was a result of the participatory action project undertaken by the mentoring team.

Reflecting on that, she notes:

“*I felt that this was both a useful and appropriate challenge as it was totally outside of my ‘comfort zone’, yet it is something that I have to become more comfortable with as much of my profession involves speaking in front of and presenting to fellow employees and clients. I feel that good way to become more comfortable with this form of communication would be to practice it.”*

Claire’s comments highlight the pain of change, and the demands it places on people because it forces them to step out of the familiar and into uncertainty. Her comments also highlight that the only way to deal with being uncomfortable in an unfamiliar situation is to continue to practice dealing with the unfamiliar. This is an important aspect of change – embracing the uncertainty that it entails (Anderson, 2011) and coping with that uncertainty. Claire realizes this, noting that despite her fear of public speaking and concerns that her nervousness was obvious to her audience, that it was still important to make her presentation to the host course students because it allowed her to practice *not* being nervous. It also allowed her to develop herself as a leader. She says of this:

"*As usual, I had apprehensions before presenting. It is never something I look forward to…however once people arrived and I began presenting, the misgivings I experienced before slowly went away…. As a leader, I felt really proud that I was able to step out of my own shell and pass along the wisdom that I have learnt over the last five years onto junior students."*

The growth challenges were a deliberate activity meant to address aspects of their individual personalities that they perceived held them back from fully realizing their leadership potential. Their responses demonstrated the difficulties and rewards of choosing to change, providing an intricate portrait of a change process. This is valuable, because it shows how hard it is to provoke change at the individual level, which can be extrapolated to the institutional level, as institutions are simply a large collection of individuals, each of whom must navigate the uncertainty of change – provided they are aware of changes needing to be made, and if so, whether they have a desire to make those changes.

5.2.2. Peer Mentor Experience: Leadership Philosophy

In addition to their growth challenge, the mentors were also asked to formulate their own leadership philosophy. Although they were not asked to specifically respond to their growth challenge in this assessment piece, the purpose of the growth challenge was to incite their thoughts on who they were as leaders. The leadership philosophy assignment therefore attempted to capture the change, if any, that they underwent as participants in the pilot program.

Additionally, the leadership philosophy assignment guidelines were focused on helping them create a piece of writing that they could refer to as they entered professional engineering practice, or that might be useful to them when asking for promotions or applying to leadership. Therefore, they were asked to synthesize their views on engineering and their understanding of themselves as engineers with their ideas about what it means to be a leader. A selection of the assignment guidelines is given below:

Throughout the course we have examined various topics and themes related to engineering, teaching and learning, as well as leadership. Reflecting back on the various course readings, class discussion, practicum placement, and your own engineering education and professional (i.e. internships) practice, write a short document (1000 – 1500) words that speaks to the following:

- *How engineering can impact local, national, and global communities*
- *What are important areas of local, national, and global change for engineering to address*
- *Your view on how an individual creates change and the circumstances for change*
- *Your understanding of yourself as a leader, and what it means to be an effective leader*

This piece of writing is meant to be something that you can refer back to as your practice as a professional engineer develops. It is also intended to be a document that may be useful as a supplementary addition in an employment application, or re-worked at an appropriate time in a bid for promotion or competition to lead a particular work project.

Therefore, this write-up should read as though it is addressed to a person, or group of persons, that are interested in hearing your thoughts on what it means to be an engineer, a leader, and an effective agent of organizational change.

Prior to submitting this assignment, the mentors had already written three critical reflections and were therefore familiar with reflective writing. Their philosophies were compelling and insightful:

KATY

Power and leadership were the main themes of Katy's philosophy. She wrote at length about the importance of staying open to new ideas, and embracing instead of fearing change. She connected her discussion of change to leadership, and the importance of being supportive of others as a leader during times of change. Additionally, she discussed the power that leaders can hold over other people, and how being able to realize that power and instead of approaching relationships from a place of authority, to approach them as a team member:

"Power and leadership tend to fall hand in hand, and it is important to constantly be aware of your surroundings, especially the people that surround you. For this reason, leadership requires strong teamwork skills. To lead a team, one must first understand team dynamics and how to address failures, as well as, successes. I've worked within a team where the leadership was lacking, and this was because the individual did not have enough experience as a member of a team, rather than as the leader of the team."

Her response highlights the importance of leading a change process by being aware of the people you are leading through that change, as well as ensuring that you work with people in making that change instead of directing others.

CLIFF

Responsibility and leadership were the main messages Cliff spoke to in his writing. He discussed his love of problem-solving as an engineer and being focused on the specifics of responding to a problem – and not the wider impact on society of the problem and its possible solutions:

"As I further explored the field of engineering, I found myself always questioning; what kind of engineer designed that? or how could someone ever come up with that complex device? At the time I didn't consider the large impacts that an engineer's work can have on the world…As an individual soon to be entering the work force it is crucial to understand how much influence my career could have on the world. Although it may go unnoticed, each and every decision made by an engineer has the potential for global change."

This was a significant shift in Cliff's thinking, as at the beginning of the course, his idea of leadership was more about being able to direct and lead projects and people. Although that was still an important theme in his philosophy, he also spoke to the engineering code of ethics, and how being a leader in engineering was also about being able to continually make the world better through engineering.

CLAIRE

Change and leadership were the main themes in Claire's philosophy. Specifically, Claire was focused on changing engineering practices and discourses towards more sustainable design. To her, being a leader in engineering was directly connected to environmental stewardship. She was clearly aware of the impact engineering does and will have on the physical world, and as a leader she wanted to ensure that engineering practice could be responsive to the changes taking place in the local, regional, and global environments:

"Today, and in the foreseeable future, the main focus of many members of our society is quite bluntly, trying to save our planet. The rate of consumption, pollution, population growth, etc., is destroying our planet. These issues affect all areas of local, national, and global communities and some of the required change can stem from engineering solutions. It is our generation that has to step forth and create these solutions that are needed – our generation of engineers…
I feel that many individuals create change by feeling pressured by the circumstances for change. For example, if climate change was not a concern, it would not be a focus for change…This can lead to a snowball effect where many people on a global scale work together to find a solution to a problem…if we all work together I believe we can find a solution and achieve anything that we set our minds to."

Although she had a very positive outlook on being able to lead change in terms of responding to environmental sustainability, she also noted the difficulty of leading change as a female engineer:

"I want the world to be a less polluted place…However, as a woman in the engineering field, I am a minority and find it difficult to find a way to achieve this. The field of engineering is still male dominated and at time, archaic in the way that it treats women, especially in the construction industry…I find that it is sometimes difficult to have a voice or a platform to which I could promote the change I want to see…Therefore, I feel the best way to mitigate this is to try to become an effective leader…If I voice my concerns and opinions and strive to find a solution than I am hoping that others around me will be motivated to take up the torch and help me work towards the same goal."

For Claire, being an effective leader was not a goal in and of itself, like it was for Katy and Cliff. Certainly, Katy and Cliff were aware of power relationships and ethical decision-making, but for them that was caught up in being an effective leader. For Claire, being an effective leader was the launching pad for achieving the larger goals she had for herself and her professional practice. In this respect, it was Claire who best understood the goals of the seminar course readings and indeed, the curricular peer mentoring intervention in its entirety: to create institutional change.

For the mentors to get to this point in their thought processes and their writing, they had to undergo a significant amount of change not only on a personal level as prompted by the course readings, assignments, and activities, but also in how they were accustomed to thinking and learning. The leadership philosophy assignment asked them to write from a personal, non-technical standpoint. It was asking them to think about the broader implications of their education and future professional practice, instead of being focused on the specifics of that practice. It was asking them to position themselves as changemakers and leaders, not compliant students and future employees. It was therefore asking them to be imaginative – to think beyond their immediate roles and responsibilities, and beyond the minutiae of engineering practice. To get to the point that the mentors could do this effectively, it was important to build their confidence and ability in stepping away from their established writing practice (which Katy noted in her 'growth challenge' response) and building a new writing practice, as well as introducing an alternative approach to learning.

To help the mentors negotiate the change they were experiencing in terms of what they were learning, how they were learning, and what types of learning assessments they were responding to, the seminar course was deliberately structured to allow them to be successful in making that change. First off, the mentors self-selected the program, meaning they were already open to change. As already documented in Phase I, the program application materials made it clear that this course was taught through a critical engineering discourse, and that signing up for the course meant being open to non-technical learning materials, activities, and assignments. Second, they were prepared by the researcher/instructor to be successful in making those changes, as the course assignments were carefully constructed to build their abilities to respond to the types of assignments being asked of them. They were given clear assignment guidelines and marking criteria, they were offered examples of completed assignments, and they were given detailed feedback on their assignment submissions, so they could identify what worked well and what needed to change. Third, the assignments were structured with a clear purpose in mind – and that purpose was communicated to the mentors. Therefore, the mentors knew why they were being asked to do something, instead of just being told they had to comply.

5.2.3. Peer Mentor Experience: PAR Workshop

One aspect of the curricular peer mentoring intervention that was completely positive, and is a shining example of what curricular peer mentoring can provide to a university academic program was the PAR workshop that the mentors hosted for the students in the host courses[61]. This was a self-directed project that the mentors had full responsibility for planning and delivering to their student peers. It was a useful and successful addition to their peer mentoring practicum, and the most visibly effective activity of their mentoring practice.

The PAR Workshop was the result of a collaborative course project the mentors undertook in fulfillment of the course requirements. It was a workshop hosted by the mentors for the students in the host courses, and was significant to their leadership development because it was an entirely self-directed and planned activity. Using the Participatory Action Research (PAR) method, the researcher/instructor asked the mentors to identify a problem in the engineering program at Maple University for which they could then devise a solution. The mentors were solely responsible for designing the workshop, organizing the logistics for hosting the workshop, and for delivering the workshop. The workshop was open to all engineering students, and was advertised via posters and the faculty's closed-circuit televisions. The workshop specifically targeted the junior students in the host courses, and these students were invited to attend by the

[61] PAR Workshop Presentation Outline & Poster Advertisement is available in APPENDIX T & U.

mentors via the social media groups set up by the mentors for their respective courses. Attendance was not mandatory, and unfortunately some host instructors did not emphasize the value of the workshop to their students, which likely further impacted attendance levels.

In total, there were a maximum of 25 students in attendance (students came and went as needed depending on their class schedule) which was a low percentage considering the overall pool of potential attendees was 497 according to the class enrolment figures for all three host courses. This was an improvement in attendance, however, from the previous faculty organized and hosted workshop that was hosted in for all students who failed their first test in the first-year engineering program. There were 150 students available to attend, and only 7 students made an appearance. This is not surprising, however, given the stigma attached to ‘being a failure’ (Omar, 2010), hence the reason the workshop hosted by the mentors was not communicated to the first-year engineering students as exclusive to students struggling with the first-year coursework. The workshop was also held at a strategically important time in the first-year engineering program: in advance of them deciding their discipline choices and prior to the final exam period. Therefore, besides the incentive of free pizza and a prize giveaway, they also had a personal and academic motivation to attend.

PAR is a collaborative process that seeks to understand a problem and engender a change to address that problem through experimentation grounded in the lived experience of those affected by the phenomenon. The underlying tenets that inform the majority of PAR projects are “(a) a collective commitment to investigate an issue or problem, (b) a desire to engage in self and collective reflection to gain clarity about the issue under investigation, (c) a joint decision to engage in individual and/or collective action that leads to a useful solution that benefits the people involved, and (d) the building of alliances between researchers and participants in the planning, implementation, and dissemination of the research process." (McIntyre, 2008, p. 1).

Like the specific curricular peer mentoring pedagogy used in this research pilot, PAR is both critical and emancipatory. Instead of simply being affected by a critical process by acting as mentors in the seminar course, they became leaders of a critical, emancipatory process themselves by hosting their PAR workshop. The mentors offered many suggestions to students about how they could be successful in their engineering education. These suggestions were entirely thought of and communicated to the students by the mentors without interference from the seminar course instructor or any other 'authority figure' within the faculty[62]. By hosting this workshop, the mentors could benefit their first-year engineering peers, and practice identifying and solving non-technical problems – an important learning moment for their future leadership activities.

They were also able to experience a new type of knowledge – emancipatory knowledge – which differs significantly from the instrumental knowledge in which most of their engineering education was based, or indeed the communicative knowledge that formed the desired learning outcomes of their non-technical engineering courses. Instrumental knowledge is one of three kinds of knowledge identified by Habermas, who saw this type

[62] Dr. William Wessel, the coordinator of the first-year engineering program, was consulted, but his involvement was limited to a 15-minute meeting wherein he listened to the mentors and their plans and securing funding for refreshments for the PAR workshop from the engineering faculty.

of knowledge as important to modern society, but also limiting due to its reliance on empiricism which assumes all knowledge must be objective if it is to be (Habermas, 1971). Communicative knowledge is acquired through shared interpretations and consensus about reality, and is therefore a subjective knowledge. It is concerned with understanding others through language, and as such concerned with social systems, structures, and beliefs (Cranton, 2011). Emancipatory knowledge questions instrumental and communicative knowledge, which is why it is emancipatory:

> Gaining emancipatory knowledge is dependent on our abilities to be self-determining and self-reflective . . . Emancipatory knowledge is gained through a process of critically questioning ourselves and the social systems within which we live. The philosophical foundation of emancipatory knowledge lies in critical theory. In this paradigm, instrumental and communicative knowledge are not rejected but are seen as limiting. If we do not question current scientific and social theories and accepted truths, we may never realize how we are constrained by their inevitable distortions and errors. Without the possibility of critical questioning of ourselves and our beliefs, such constraining knowledge can be accepted by entire cultures (Cranton, 2015, p. 315).

A key part of the building this knowledge, as initiated by the PAR workshop, was the critical questioning the mentors made of their own experience with the engineering program at Maple University. Throughout the seminar course they had explored topics that spurred the critical questioning of engineering as global force that had consequences for environmental sustainability, human population growth and migration, globalization, and technological advancement. They also critically questioned the social aspects of engineering practice, by examining issues of race, sex, power, and privilege in the contemporary Western work environment. They did not, however, critically question *their own education experience* through the seminar readings and discussions. This critical questioning was instead embedded into their preparation and hosting of the PAR Workshop.

To that end, the mentors identified an issue with how the faculty prepared engineering students for their future engineering careers. They were inspired to reflect on their own education journey at Maple University, because they were coming to the end of that journey and had been asked to provide information to the first-year engineers stemming from their education experience. They realized that the institutional culture of the engineering program at Maple University had not helped them become successful senior students on the cusp of graduating into professional engineering positions. Instead, their own personal initiative in securing additional academic and non-academic experiences relevant to their professional development had positioned them to successfully enter the workforce.

In particular, the mentors were critical of how the engineering co-op program was administrated, which was the work placement system that was orchestrated by a specific administrative department within the engineering faculty. They therefore reflected on how the inefficacy of the co-op program could be mitigated to benefit the first-year engineers as they prepared themselves for their first co-op placements. The mentors realized that the problem of how the program was run was not something they had the power to solve, but what was within their sphere of influence to change was the information that the first-year engineers received about the co-op program.

The mentors reflected on the official information given to them by the co-op program administrators and how it had not been helpful to them when they were selecting their co-op placements. They saw this lack of helpful information in determining their co-op opportunities also negatively affected their ongoing career decisions. Therefore, the mentors organized a ‘question and answer’ session at the end of the workshop that featured a senior engineering student from each engineering discipline and/or taking very different career paths upon graduating from the undergraduate engineering program.

The first-year engineering students who attended responded enthusiastically to the question and answer session. They listened attentively during the presentation components, laughed and smiled throughout, and were engaged with the question and answer session. In fact, the junior students were so responsive to the question and answer session with the senior engineers the workshop ran over time, and even after the workshop formally ended many of the students approached the mentors and/or the senior engineering student presenters that the mentors had brought in to speak. The workshop was clearly well-received by the first-year engineering students, and the researcher confirmed these observations by speaking with a handful of the junior students as they were leaving to ask their opinion of the workshop. All of them were positive about the workshop topics and format, and all of them wanted to know why there had not been a similar workshop offered at the beginning of the first-year engineering program[63], and they were curious if/when another workshop would be hosted. Furthermore, the low attendance numbers did not detract from the positive reception the workshop received from the junior students or the benefit to the mentors of organizing and leading the workshop.

5.2.4 Peer Mentor Experience: End-of-Term Group Interview

The final data collected on the mentors was their responses to the end-of-term group interview, and a written reflection from each mentor summarizing their experience within the program. The end-of-term interview was held on the last day of class, and the mentors were asked to respond to a series of open-ended questions that interrogated what they thought of the seminar course, their experience as curricular peer mentors, their views of teaching and learning, as well as their experience in the engineering program. Specifically, they were asked:

1. What readings would you keep? Lose?
2. What content did you like/dislike/would like to see in the future?
3. What assignments did you like/dislike/would like to see in the future?
4. Did you like/dislike the course seminar?
5. Did you like/dislike the practicum component of the course?
6. What was your relationship like with your host instructor? What would you keep/change?
7. How did you think the peer mentoring practicum worked? What could be done to improve it?
8. How did you think the program worked overall? What would you do to improve it?

[63] There have been workshops offered by the faculty in the past, but they have historically had low, to no, attendance.

9. What did you learn from the program in terms of the course objectives concerning leadership development? What did you learn about teaching? What did you learn about mentoring?
10. What, if any, impact has this program had for you as a senior engineering student? As a young professional engineer?

It was useful to ask them questions about the seminar course set-up, to assess how to adjust it for possible future iterations of the program. As such, they were not as pertinent to the overall data collection, because the responses to these questions did not have direct bearing on either phase of the program. The remaining questions, however, were important to assessing the intervention from the standpoint of the mentors – the research population at the heart of the curricular peer mentoring intervention.

The questions about their experience with the practicum component and host instructor relationships were crucial to understanding what, if any, affect that the curricular peer mentoring intervention had in changing the institutional culture around teaching and learning in the engineering faculty. When asked what they liked or disliked about the practicum component, the mentors commented that the lab classes (i.e. the smaller, practice-oriented classes) were the most effective space to situate their mentoring practice – although not all labs had material that would facilitate mentoring. They also noted that the more the course progressed, the less the junior students were engaged with the mentors. The mentors explained this by discussing the overwhelming nature of the first-year engineering program.

They would improve the practicum component of the pilot program, and the curricular peer mentoring intervention overall, by having the curricular peer mentors sourced from a different academic term than the one they had mentored in because during their preferred term they were senior enough to provide academic support and a perspective of the program from an informed standpoint. They would also have a specific cohort of senior students mentor a specific cohort of junior students, as this was the first term that the junior students would enter their chosen engineering discipline and the mentors thought this would provide a natural bond between the mentors and the mentees. They could still mentor the first-year engineering students in the Spring/Summer term, which the mentors thought would be the most beneficial place to offer mentoring to the first-year students as the Spring/Summer term was where the ‘at-risk’ students were most likely to be, as the stronger students would have already completed the first-year engineering course requirements by then and likely entering their first work term. They also commented that it would be more fun and interesting for the curricular peer mentors to mentor in the courses they liked, and that having peer mentoring teams would be optimal given the large course sizes, as this would help the task of peer mentoring feel less overwhelming.

As to their respective relationships with the host instructors, there were varied opinions given the different circumstances experienced by each mentor. Katy commented that Instructor 3 did not seem to realize that she was a fulltime student and had many other responsibilities on top of her coursework. She had to tell him that doing all his class assignments was not necessary, nor was it realistic for him to have that expectation. She and Instructor 3 had a good working relationship however, meeting weekly and Katy noted that Instructor 3 did not have any issues with her role in his course and her activities within his classroom.

Cliff had a distant relationship with his host instructors and did not meet them at all. He commented that this was largely his own doing. He did not think that Instructors 1 or 4 were particularly aware of the little peer mentoring he did, and commented that they never sent out an email he had asked them to forward to the host course students inviting them to join the Facebook group he had set up for the students in the class.

Claire felt Instructor 2 wanted to preserve the traditional classroom hierarchy, and was told not to actively involve herself in his course or with the students unless they contacted her first with a question. If they contacted her, Instructor 2 requested that Claire not provide an answer to their questions or assist them in anyway, and instead direct them to Instructor 2 or one of his graduate assistants. Claire did not feel comfortable asking for any meetings with Instructor 2, and was told he would not contact her.

In terms of the personal change experienced by the mentors, they noted how helpful it was to them personally to develop better tools for reflecting on themselves and their work. They learned about the value of reflection, and in doing so deepened their understanding of concepts and ideas they were aware of before on a superficial level. They also found their peer mentoring practice allowed them to reflect on their own engineering education, and helped them become more confident about, and aware of what it meant, to be a professional. They found the seminar course spurred their thinking about their future engineering practice, and gave them space to think about being a better person or leader in their future careers. They also found the pilot program practicum let them see why some professors taught the way they do, and what made certain professors or work-term supervisors effective teachers and leaders.

Other comments offered by the mentors, were the need to advertise the curricular peer mentoring course much sooner, to allow time for the senior engineering students to plan how to incorporate it into their academic schedules. On that note, they suggested that the course be added to the list of electives that are distributed to all students in advance of each term. Most significantly, they thought that the course should run in tandem with, or even replace, the courses taught by Professor Karen King that are designed to capture all the non-technical 'essential skills' required by the engineering accreditation board, which the mentors reported were disliked by the engineering student body.

Their written summaries of their experience in the program supported the group interview data. The summaries that they submitted further highlight the individual change process that the mentors went through on a personal level, as well as their perspective on the institutional change process being encouraged by their curricular peer mentoring practice.

5.3 Understanding the Mentee Experience

To understand the mentee experience, surveys were distributed to students in all three host courses on the last day of class at the end of term. This date was deliberately chosen in order to catch as many students as possible, given the mentors had made it clear to the researcher that attendance dropped rapidly and significantly as the term progressed, but often students attended the last day of class because this is when most course instructors would discuss the exam and provide any study tips and/or study guides.

5.3.1. Student Surveys

As discussed at length in Chapter 3: Methodology, three courses were selected to participate in the pilot curricular peer mentoring program: ENGI A, taught Instructor 2;

ENGI B, taught by Instructor 3; and ENGI C, taught by Instructors 1 and 4. These first-year engineering courses that prepare students for future engineering studies by establishing a broad knowledge base to underpin their discipline-specific coursework in their second, third, and fourth years. These courses were specifically selected given their level of difficulty compared to the other first-year engineering courses, and their low retention rates[64].

Over a five-year period[65] Instructor 2's ENGI A course had a failure rate of 23%, Instructors 1's and 4's ENGI C courses and the ENGI B courses taught by Instructor 3 had a fail rate of 25%. Combined, the failure rate for the host courses taught by the host instructors during this period was 23%. In total, there were 6615 students taught in all ENGI A, B, and C course offerings during this five-year period, with 1505 failing. Therefore, the combined failure rate for the host courses taught by all faculty (not just the host instructors) was also 23%, meaning there is no significant difference in student performance due to the instructor of record.

In the pilot program host courses specifically, the failure rate was: 20% for ENGI A, 18% for ENGI B, and 23% for ENGI C.[66] Therefore, the pilot program term student performance statistics show little to no improvement in retention rates over the five-year data set, with approximately a fifth of all first-year students not achieving the pass rate required to move onto to second year studies. Retention rates over the course of the entire

[64] Student GPAs were calculated for each instructor based on total number of students each instructor taught between over a five-year period. Over that period, Instructor 2 taught 916 students in ENGI A, with 212 failing; Instructors 1 and 4 taught 866 students in ENGI C with 215 failing; Instructor 3 taught 338 students, with 86 failing.

[65] Dates removed to preserve participant anonymity.

[66] In the pilot program, there were 161 students enrolled in ENGI A, 33 students failed; there were 177 students enrolled in ENGI B, 32 failed; there were 180 students enrolled in ENGI C, 41 failed.

program are also poor, for example, with the engineering class of 2005 beginning with 660 fulltime students, which dropped to 192 students in year 2, with only 126 students graduating in 2009.

The survey used was modeled off the same student survey employed by the University of Calgary Curricular Peer Mentoring Program. This was a deliberate choice, as the researcher wanted to ensure options to compare her data with the UofC data set would be available for future research purposes. Also, by using an established survey instrument that had been formulated and reworked over a 10-year period gave credibility to the survey. Despite strategically choosing a survey distribution day, and ensuring the surveys were distributed hard-copy, in-class to maximize completion rates, the response rate was relatively low. The aggregated response rate, and response rates for each course is below:

5.3.1.1 Survey Breakdown: Response Rates

All Courses

- Total students available to be surveyed: 518 (according to class enrolment numbers)
- Total students surveyed: unknown due to survey distribution issues
- Total survey respondents: 176
- Survey respondents that responded to the survey in more than one host course: Maximum of 7
- Partially complete responses: 5
- Incomplete responses: 5

ENGI C

- 180 students enrolled in course
- 99 students present the day of survey distribution
- 99 surveys returned
- 2 partially complete
- 2 incomplete
- Larger numbers returned from ENGI C is due to the survey distribution being done by the program coordinator.

- All students present in both sections of the class on the final day of class were surveyed. There were 99 students present. All students returned surveys to the program coordinator. Response rate for the students present in both classes is 100%

ENGI B

- 177 students enrolled in course
- Number of students present the day of survey distribution is unknown
    - The response rate can be extrapolated using a similar attendance rate of 55% in ENGI C, which would leave approximately 98 students in attendance for ENGI B gives a response rate of 67%
- 66 surveys returned
- 3 partially complete
- 3 incomplete
- Smaller numbers returned from ENGI B possibly due to survey distribution being done by assistants

ENGI A

- 161 students enrolled in course
- Number of students present the day of survey distribution is unknown
    - The response rate can be extrapolated using a similar attendance rate of 55% in ENGI C, which would leave approximately 89 students in attendance for ENGI A gives a response rate of 12%
- 11 surveys returned
- All returned surveys completed
- Smaller numbers returned from ENGI B possibly due to survey distribution being done by assistants as the course hours for this host instructor conflicted with my teaching schedule and instructions given by the host instructor that students not complete the survey unless they had had significant interactions with Claire. There was little class time given for students to complete the survey, and they were unable to complete it after class.

5.3.1.2 Survey Breakdown: Demographics

The survey asked students in the host courses basic demographic questions concerning their gender, their age, and their discipline area. At the time of the survey, students were still in the process of choosing their disciplinary specialization, and therefore some students have indicated they were in “Engineering” or “Undeclared” as they were yet to select a specific discipline. This data is visualized below:

DEMOGRAPHIC OVERVIEW:

Gender

1) 109 Male respondents
2) 60 Female respondents
3) 1 Non-binary gendered respondent

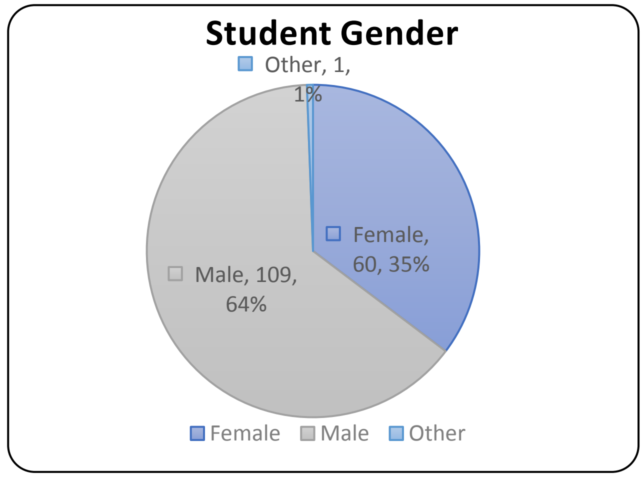


Figure 7: Student Survey 'Gender'

Age

4) 18 years old: 108 respondents
5) 19 years old: 43 respondents
6) 20-25 years old: 15 respondents
7) 26 – 40 years old: 4 respondents

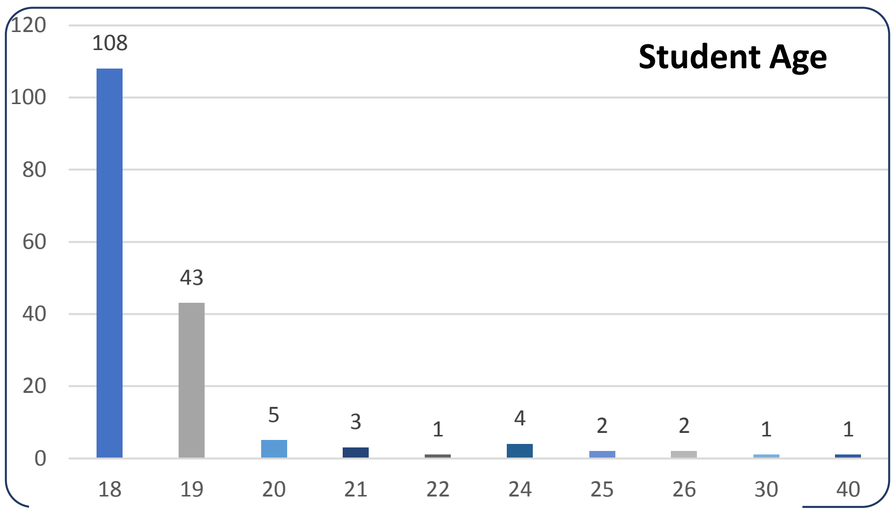


Figure 8: Student Survey 'Age'

Discipline Breakdown:

- Mechanical: 55
- Engineering: 43
- Civil: 28
- Electrical: 9
- Process: 8
- Computer: 5
- Ocean: 4
- Undeclared: 2
- Other: 1

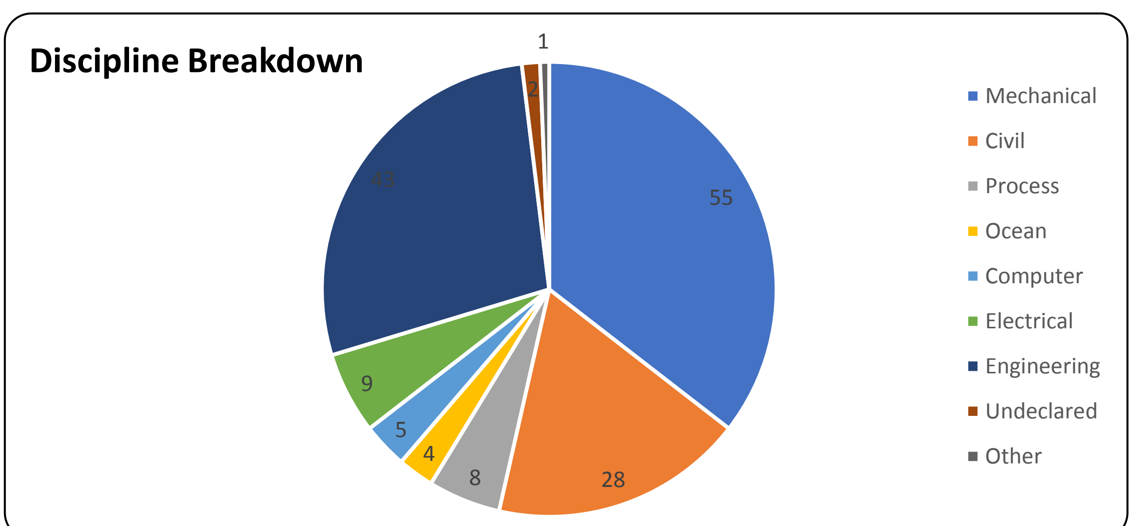


Figure 9: Student Survey 'Discipline'

In addition to this basic demographic data, targeted demographic questions asked the students in the host courses to state what their current GPA was, what letter grade they expected to get in the host course, how many hours a week they spent preparing for their host course and whether that was more, equal, or less than the preparation they put into their other courses. Finally, they were asked to estimate the time they spent each week in terms of hours at work, volunteering, or caregiving. This data was collected to get a sense of how the students understood their performance in their courses, how much time the students spent each week on their curricular and extracurricular activities, and whether there was time for the students to actively engage with their curricular peer mentor.

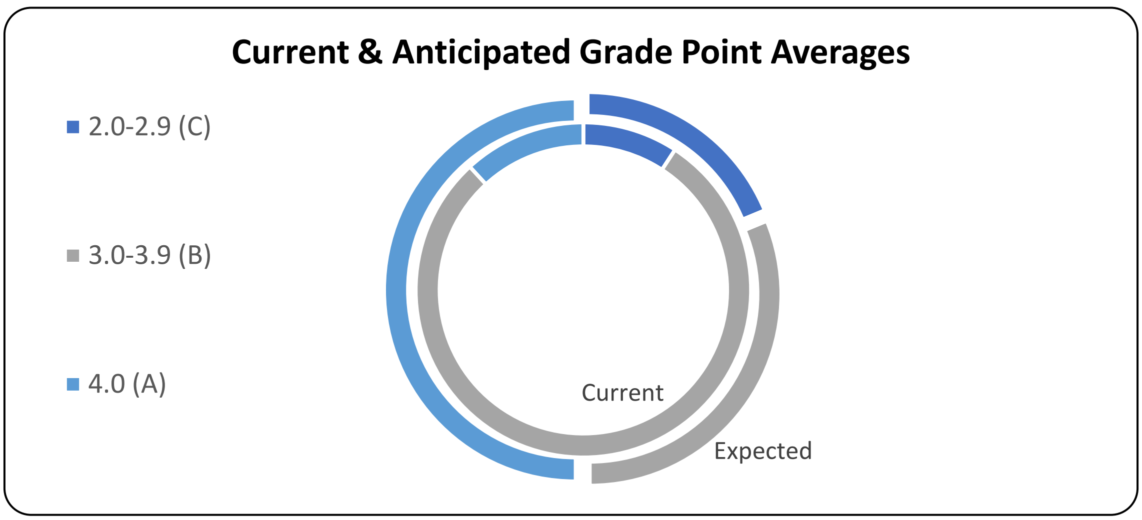


Figure 10: Current & Anticipated GPAs (160 responses, 17 no response)

The maximum reported GPA was 4.0, or an 'A' level grade, and the minimum reported GPA was 2.2, which was a 'C' level grade, and a majority of the of respondents indicated they currently held a GPA of 3.0- 3.9, or a B' level grade, which accounted for 79% of the responses. It is interesting that more students anticipated receiving an 'A' level grade than their self-reported current GPAs indicated was likely. Of the 160 respondents, 6 students gave a range between 'A' to 'B' as their anticipated letter grade, and 2 students gave a range from 'C' to 'B' as their anticipated grade, with the rest of the respondents choosing one grade category only, with 48% expecting an 'A' grade, 31% expecting a 'B' grade, and 19% expecting a 'C' grade. Despite there being 48% of students reporting that they were anticipating an 'A' letter grade, only 18% currently held an 'A' level grade. This discrepancy in their current and anticipated grades suggests a mismatch between student expectations of their performance and the reality of that performance. This may also explain why many respondents made comments (reviewed in the following section) about not interacting with the peer mentors because they perceived themselves as not needing assistance – an insight into engineering students and their unwillingness to seek help noted by Professor Jackson.[67]

This explanation for student comments about not participating in the program is more likely than students not having the time to participate, as most students did not have demanding extracurricular responsibilities. The maximum amount of time that students spent in employment was 30 hours a week, but that was only applicable to one survey respondent, and only five other respondents worked 20 hours or more a week. The average time spent in employment every week by most students was 2.4 hours, and only 33 out of the 160 respondents reported working at all. In terms of volunteer commitments, the maximum amount of time reported was 17 hours a week, and again this was only attributed to one respondent, with the majority of the other 35 respondents who reported volunteering doing so for 5 hours or less a week. Only one person noted working and

[67] See 'Senior Administrator Interview', Section 5.6.

volunteering extensively, for a combined total of 18 hours a week. Another four people responded that they also spent time working and volunteering, but in each of these cases the combined hours they spent weekly on their activities was 8 hours or less.

Thirteen students reported caregiving duties, with one person noting they spent 10 hours a week volunteering and 5 caretaking, another reported 12 hours in employment and 4 caretaking, another saying they spent 8 hours a week working and another 8 caretaking. One respondent both spent time in employment, volunteering, and caretaking for a total of 13 hours a week, four others reported caretaking between 5-10 hours a week, and two respondents only spent two hours or less a week caretaking exclusively. There were three respondents whose employment and caretaking commitments took 20 to 25 hours a week respectively. All these respondents were women and 18- 19 years of age. Therefore, most students had the time to interact with the mentors, as very few respondents spent more than 15 hours a week combined in employment, volunteering, or caregiving.

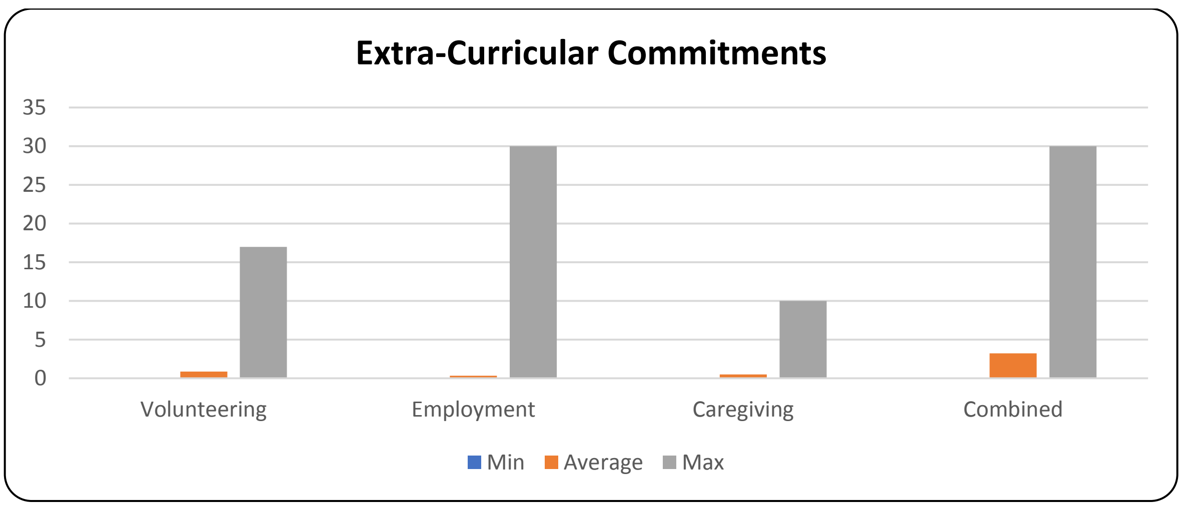


Figure 11: Extracurricular Commitments

Additionally, most respondents did not report spending a significant amount of time studying each week. Most students studied for an average of 5 hours a week, with 21 respondents reportedly studying for 10 hours or more per week, with one of those students indicating they studied 20 hours a week. This student had a GPA of 3.2, which is a solid 'B' grade and the necessary grade level a student must have to be accepted into the engineering program. He was also a 'mature student' at 30 years old, reporting no extracurricular weekly activities, and indicated he was in his 5th year of study in a general Sciences program. He didn't indicate holding any previous degrees, therefore, it is possible that this student was taking an engineering course as part of his Sciences program and spent so much time studying because he was in the ENGI B host course and perhaps unfamiliar with the course content. Of the remaining 19 students, 18 were in their first year of their program and 18-19 years of age, with 2 students in their second year of their program and 20 and 22 years of age.

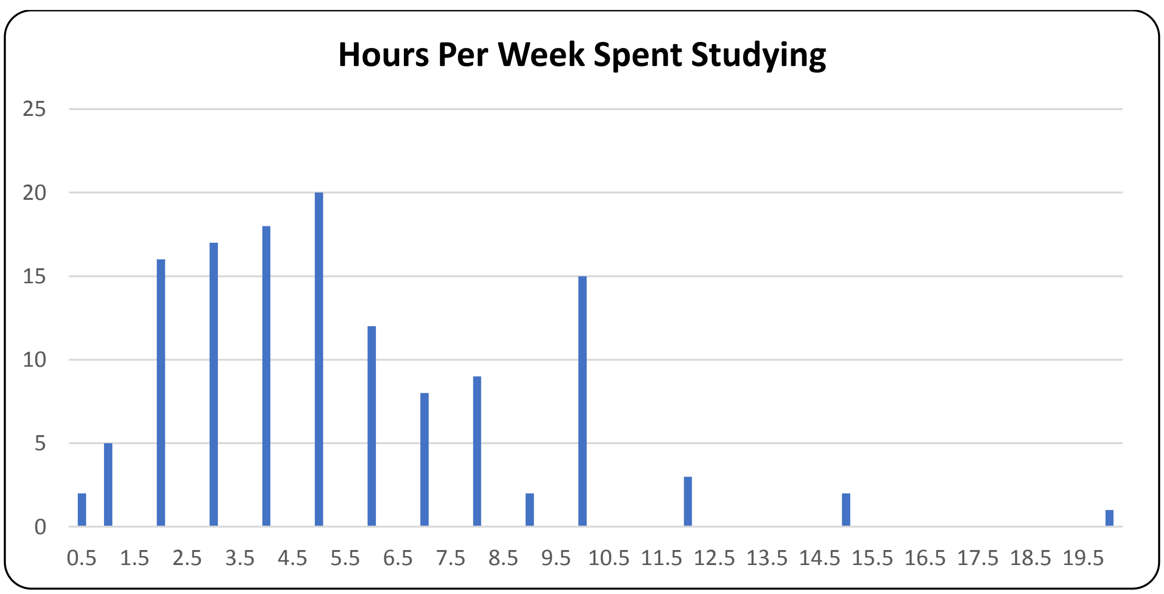


Figure 12: Hours per Week Spent Studying

A total of 168 students responded to the question about how much time they spent studying for their host course compared to their other courses. The majority of the 21 respondents who indicated studying 10 hours or more per week also indicated they spent more time studying for their host course than compared to their other courses, with only 6 respondents saying they spent equal time, and 1 saying they spent less time than average studying for their host course. The remaining 147 students however, spent equal not more time studying for the course. Only 50 students reported spending more time studying for their host course, with 73 saying they spent an equal amount of time, and 17 saying they spent less time, studying for their host course.

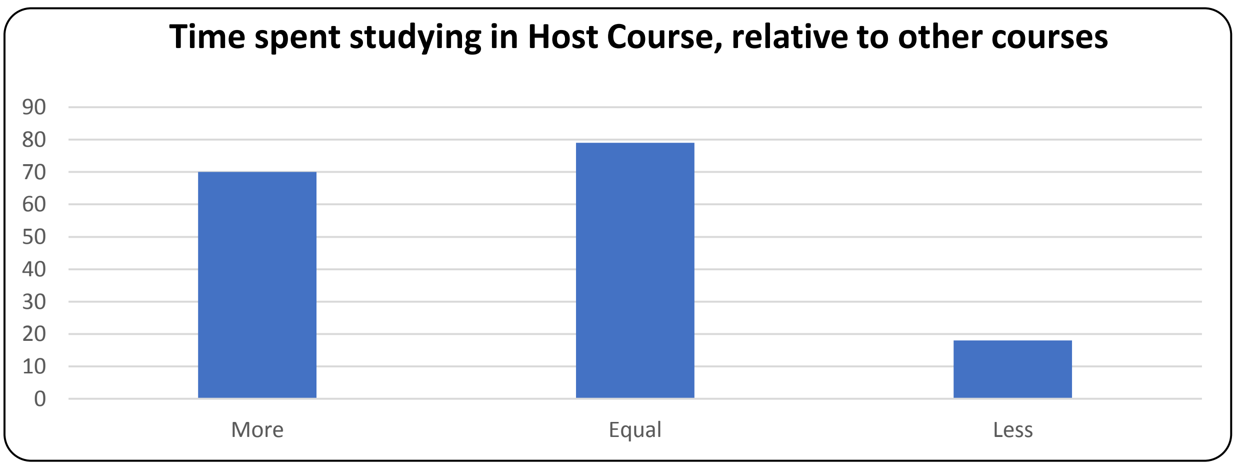


Figure 13: Time spent studying in Host Course, relative to other courses (172 respondents, 4 no responses)

It’s unfortunate that there were so few survey respondents from ENGI A, because even among the few students who did respond, the majority of them indicated they spent more time studying for Instructor 2’s course compared to their other engineering courses. This may indicate the course material was more challenging to other first-year engineering courses. Indeed, one student said, “Support would have been helpful had we had it”.

5.3.1.3 Survey Breakdown: Student Responses

Following this demographic data, students were then asked to respond to a series of “Yes” or “No” and/or fill-in-the-blank questions about their involvement, if any, with the peer mentor assigned to their course. These questions were helpful in establishing the awareness about the program that students in the host courses had, and whether their level of awareness about the peer mentoring intervention was added, hindered, or unaffected by the host course instructor or the mentor assigned to their course.

First, they were asked about the level of communication about the pilot program, and participation displayed by the peer mentor, within the host course:

- The instructor/TA explained the peer mentor(s)'s roles near the beginning of term
  - *138 ‘Yes’, 8 ‘No’*
  - *29 No Response*
- I heard the peer mentor(s)'s introduction in class
  - *134 ‘Yes’, 10 ‘No’,*
  - *31 No Response*
- I observed the peer mentor(s) participate actively in the classroom setting X times
  - *Maximum ‘6 times’, Minimum ‘0 times’, Average ‘1.5 times’*
  - *77 Responses, 69 No response*
- I heard the peer mentor(s) announce an activity or availability X times
  - *Maximum ‘5 times’, Minimum ‘0 times’, Average ‘1.35 times’*
  - *114 Responses, 62 No response*
- I heard the peer mentor(s) give one or more presentations in class X times
  - *Maximum ‘`3 times’, Minimum ‘0 times’, Average ‘1 time’*
  - *111 Responses, 65 No response*

Second, they were asked about the level of communication they received from their peer mentor outside class time:

- I received a peer mentor's email or online message sent to the whole tutorial/class approximately X times
    - *Maximum '20 times', Minimum '0 times', Average '1.88 times'*
    - *90 Responses, 86 No Response*
- I received a personal email message from a peer mentor approximately X times
    - *Maximum '6 times', Minimum '0 times', Average '0.17 times'*
    - *75 Responses, 101 No Response*
- I received a peer mentor's written feedback on my draft, assignment or performance approximately X times
    - *Maximum '2 times', Minimum '0 times', Average '0.6 times'*
    - *72 Responses, 103 No Response*

They were also asked about their interactions, if any, with their peer mentor during class time:

- I participated when the peer mentor(s) facilitated (or co-facilitated) a small-group or large-group discussion or activity in class X times
    - *Maximum '2 times', Minimum '0 times', Average '0.2 times'*
    - *72 Reponses, 103 No Response*
- I talked with the peer mentor(s) in the classroom or hallway during a break, or before or after the class began X times
    - *Maximum '2 times', Minimum '0 times', Average '0.9 times'*
    - *75 Responses, 101 No Response*

Additionally, they were asked about their interactions, if any, with their peer mentor outside of class:

- I replied to a peer mentor's email or online message approx. X times
    - *Maximum '6 times', Minimum '0 times', Average '0.3 times'*
    - *67 Responses, 108 No Response*
- I asked the peer mentor(s) a simple, quick question via email approximately X times
    - *Maximum '5 times', Minimum '0 times', Average '0.2 times'*
    - *74 Responses, 102 No Response*
- I asked the peer mentor(s) for advice or feedback via email approximately X times
    - *Maximum '4 times', Minimum '0 times', Average '0.2 times'*
    - *74 Responses, 102 No Response*
- I participated in an activity offered by the peer mentor outside of class time X times
    - *Maximum '2 times', Minimum '0 times', Average '0.2 times'*
    - *71 Responses, 105 No Response*

- I met the peer mentor during their announced hours or I made an appointment with the peer mentor X times
    - *Maximum '2 times', Minimum '0 times', Average '0.1 times'*
    - *72 Responses, 104 No Response*

Furthermore, this section asked them specifically if they attended the PAR Workshop hosted by the mentors, and if so, what feedback they might have about the session. If they had not attended, they were asked why. Of the 163 students who responded to this question, only 8 indicated they had attended the workshop. However, it clearly was a positive experience for students who did attend, with one student in ENGI B responding to the question, "What peer mentoring activities or roles were most beneficial to your learning experience this term" that *"Katy set up this meeting thing where she could answer all our questions + free pizza ☺"*. Finally, it also asked them about whether they felt their peer mentor was accessible enough either (1a) during class or (1b) outside of class through group activities, (1c) one-on-one mentoring, or (1d) online interactions. Among those survey respondents that did reply either "Yes" or "No", the responses were split down the middle. The only question that had a significant majority of respondents indicating that "Yes" their peer mentor was accessibility enough, indicated this was via online platforms.

Students were also asked to provide a total number of hours, if any, they thought they had spent interacting with mentor assigned to their course, or reasons for their non-participation. Most students indicated spending '0' hours interacting with the mentors, to a maximum of 10 hours, and an average of 0.35 hours a week.

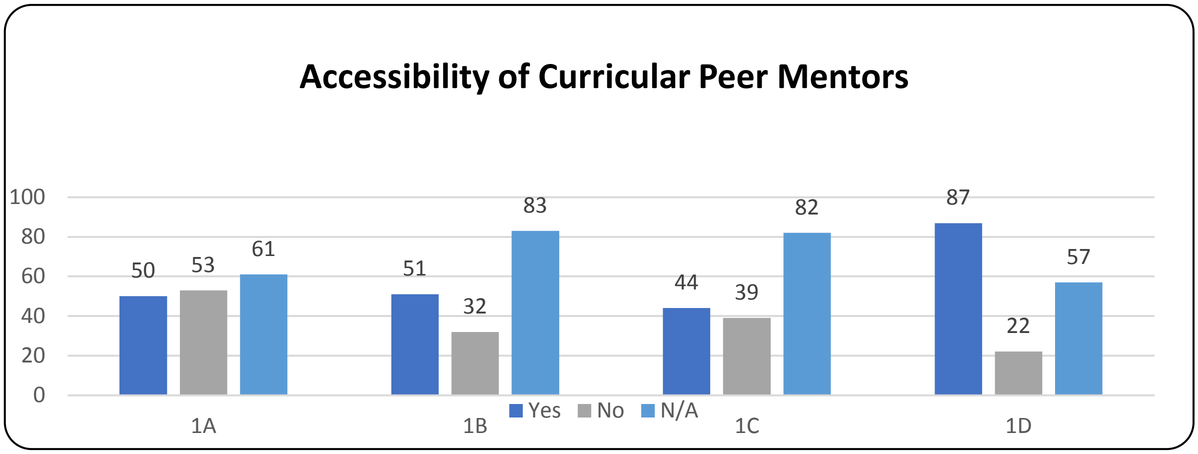


Figure 14: Aaccessibility of Curricular Peer Mentors (105 Responses, 71 No response)

Following from this section, there were three main questions asked of the students, which were broken down into a series of sub-questions/statements that the students responded to using a Likert-scale that asked them to rate their response to each question/statement on a scale of 'Significantly Negative (SN) Effect', 'Moderately Negative (MN) Effect', 'No Difference (ND)', 'Moderate Benefit (MB)', 'Significant Benefit (SB)' or 'I don't know (DK)'.

It is important to note that there were no students who reported feeling a 'Significant NEGATIVE Effect' in response to any of these questions, and almost no reports of feeling a 'Moderately NEGATIVE Effect'. Most respondents either found there was "No Difference" to their learning experience, or a "Moderate Benefit". Even though a minority of respondents indicated experiencing moderate or significant benefits from the peer mentoring intervention, most respondents who did not find the peer mentoring intervention beneficial did not experience any negative effects. Responses are captured as actual numbers of respondents, not a response rate percentage. Responses to the questions/statements are visualized below:

(4) How did peer mentoring affect the social and personal aspects of learning in this course?

a) Making the course more student-friendly, welcoming

b) Making the learning experience more interesting or enjoyable

c) Supporting my positive morale and self-confidence as a learner

d) Supporting my active participation in learning within class or outside of class

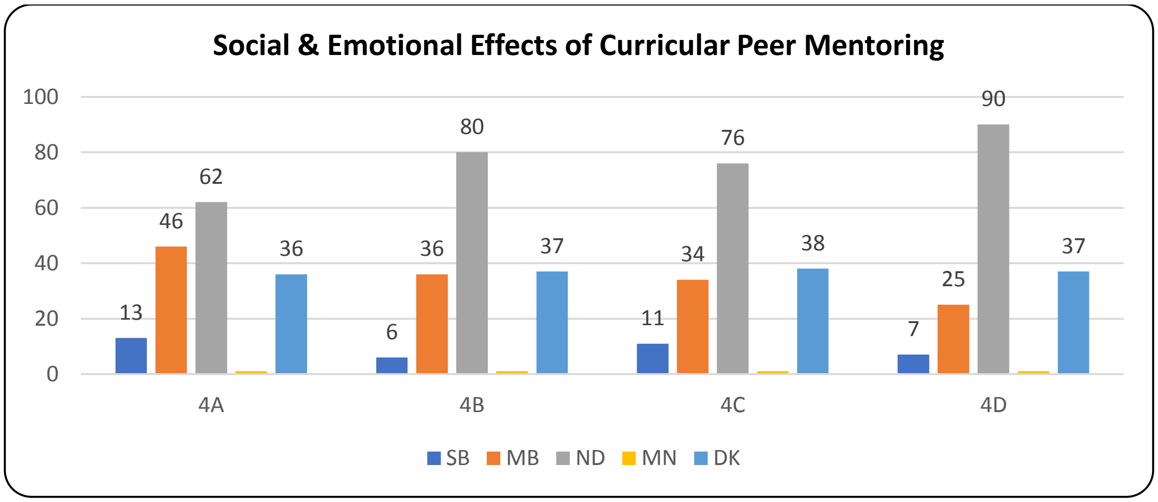


Figure 15: Social & Emotional Effects (160 responses, 16 No response)

(5) To what degree did peer mentoring activities enhance your academic learning in the course?

a) My understanding of the course's teaching and learning methods (i.e. instructor expectations, lab/assignment instructions, time management, study approaches, teamwork, course technologies, accessing course resources)

b) My understanding of the subject matter (i.e. understanding texts, lectures, the content of exams and assignments)

c) My academic skills related to the course (i.e. critical thinking, analysis, research, writing, oral presentations).

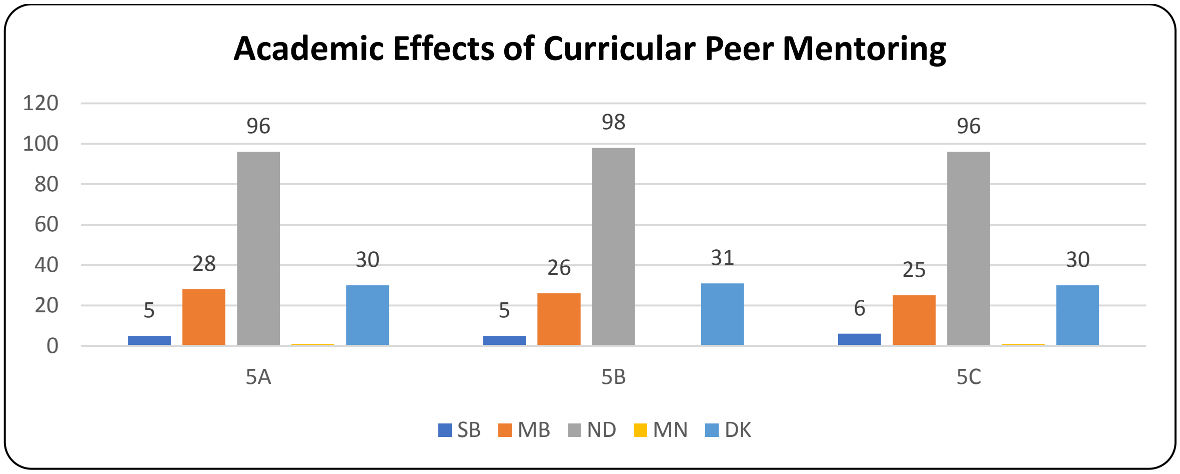


Figure 16: Academic Effects (160 responses, 16 No response)

Overall, how has the Peer Mentoring Program affected your learning experience so far?

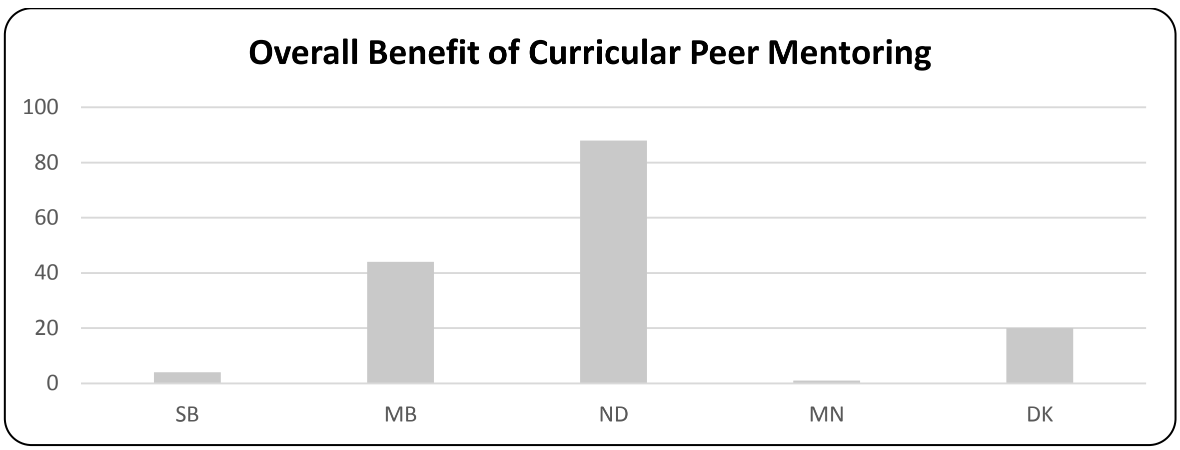


Figure 17: Overall Benefit (158 responses, 18 No response)

The above three questions also featured an invitation to provide additional comments as desired – although very few students added any additional comments.

Additionally, the students were also asked to provide feedback to their peer mentor and/or host instructor, being asked: What peer mentoring activities or roles were most beneficial to your learning experience this term? What could the instructor(s) and/or TA do to make peer mentoring more effective in this course? Do you have any messages of advice, constructive criticism, or encouragement to your peer mentor(s)?

Respondents noted that the activities and roles they found most beneficial were “During labs they have helpful hints and explained circuits and coding which helped me understand”, “They helped clear up any confusion I had”, “I feel that when we have a senior student helping you there's more motivation to do better”, “They help me contact people that can help me w/ what I need” and “They are able to tell me about their previous experiences”.

Their ideas on how to make peer mentoring program more effective centered around further utilizing them in the course and lab sessions, or offering study sessions and tutorials. Comments about this included “Get them more involved in labs”, “do tutorials”, “have regular meetings”, “facilitate a study group once a week to go over concepts covered in class”, to hold “extra practice sessions b/c very unprepared for final”, “provide examples to help”, “give more insight on what to do in labs”, “have peer mentors in the help centre around robot competition time”, “go to the help centre during the week” and finally, “hold tutorial classes once a month or so”.

The messages of advice, constructive criticism and encouragement for each mentor ran the spectrum. Selected comments for Claire include “Actively promote yourself please. Good job with FB group”, “She definitely made an effort with facebook” and “put more effort into mentoring”. Comments for Katy included “She was very nice”, “Be a part of the class, inform students you can help academically”, “Keep doing you ☺” “Please come and offer more help. Maybe make extra practice sheets”, “Be more active helping the class” and “Katy was great”. Selected comments for Cliff were “Keep doing it”, “Cliff – no advice”, “Keep it real. You’re cool. Youngin’s can relate”, “Try to be around more” and “I don’t even remember his name. He could have made himself more present by talking to us instead of waiting for us to talk to him”.

Finally, they were asked about their opinion on the peer mentoring program in general, through a final set of “Yes” and “No” and fill-in-the-blank questions:

- Had you heard of the peer mentoring program prior to taking this class?
    - *27 “Yes”, 127 “No”*
    - *21 No response*

- Have you taken (or are you currently taking) any other courses that have had an undergraduate peer mentor in them? If yes, which courses?
    - *86 “Yes”, 62 “No”*
    - *28 No response*

- Would knowing in advance there is a peer mentor assigned to a specific course's section, lab or tutorial motivate you to enrol in that section, lab or tutorial, rather than another one without peer mentor?
    - *40 “Yes”, 57 “No”, 12 “Maybe”*
    - *67 No response*

- Would you recommend to your peers taking a class where learning is facilitated by a peer mentor?
    - *86 “Yes”,39 “No”, 2 “Maybe”*
    - *48 No response*
- Are there any OTHER courses you’ve taken that would benefit by having a peer mentor? If so, please list.
    - *42 “Yes”, 26 “No”, 2 “Maybe”*
    - *106 No response*
    - *Courses listed: All first-year engineering courses (including the Maths & Physics courses not offered within the engineering faculty). The course taught by Instructor 2, was the first-year course most noted as benefitting from a mentor.*

This data was useful in determining the overall response the students in the host course had towards the curricular peer mentoring intervention, although the response rate for each question was variable. Indeed, a concluding section asked them about their willingness to participate in future research on the program, but the response rate was so low it was not feasible to gather any further data from the student mentee research population.

5.3.2. Discussion of Student Survey Data.

The major trends for non-participation or minimal participation in the program identified across the survey data returned from all three courses indicated that (i) students either did not feel they needed to use the program, found it difficult to connect to the program and/or did not know about the program, (ii) there was minimal and/or ineffective support from host instructors making it difficult to effectively embed the mentors in the course (iii) the mentors lacked personal efficacy.

Students commented on not feeling they needed to use the program, “Already have degree (used to course load), doing well in course”, “Didn’t need help”, “I didn’t see the purpose, it wasn’t of use to me” “I didn’t feel it was a wise use of time”, “Studied myself with help center and YouTube videos” or “I’m doing really well in the course without help”. When noting their difficulty with connecting to the program, many students commented they “Didn’t know about it” or there was not contact information for the mentors made readily available to the students, or the mentors simply were not around. For example, comments about Cliff’s presence in his course were largely centered on his lack of presence: “Didn't know much about him. Didn't hear anything from him or see him after initial introduction” or “Didn’t know much about him or how to get in touch” or “I’ve never seen him around” or “Did not realise that this program was still running, and did not see our peer mentor around at all”. Perhaps most apt was the question one student asked about the program: “Is it a real thing?”

Similar comments were returned for Katy too: “I didn’t know she was a mentor” or “She wasn’t around ever” or “She did not really interact with us.” Perhaps the most negative response concerning Katy’s peer mentoring activities was “She had nothing to offer, she didn’t discuss helping academically”. This was surprising, given the level of effort Katy had put into her mentoring practice. Additional survey responses indicated a divide in opinion with positive comments such as Katy “Created a more friendly [sic], community-type environment”, “Katy knew how to interact with students of this class”, “The peer mentor Katy really made herself available to us any time we wanted to ask her a question or concern”, “Was available to get in contact with through facebook discussion group”, “Katy was very friendly and seemed extremely approachable”, “She was great. Nice. Approachable”.

One student noted both a negative and positive element to Katy’s presence in the class: “Katy, our mentor was great. Super friendly and tried in every way she could to connect with us, but I can't say it helped a whole lot when it came to the course, content, but I didn't ask questions about the course, so I wouldn't really know”. Another student noted negative and positive elements to her presence as well, saying “She was there the first class, then made apoligetic [sic] posts about never being around, plus she had her own work to do so there were no hard feelings”. Other student comments indicated their awareness of the intensity of the senior student workload, which was an issue discussed by the mentors, as the senior levels of the program are very work intensive and include a year-long group project that is often undertaken in relationship with local industries. This makes the additional time requirements of peer mentoring challenging.

Three students in ENGI B, which was Katy's host course, were aware of the senior student workload: "She was busy with her own studies. I did not want to take her from them" or "She had her own work to do", "She's [a senior student with] her own stuff to be at" and "She's [a senior student]! She wasn't in the lab to help so I assume she was too busy to do anything related to ENGI B" or simply, "Getting a busy engineering student to take on this course is not a smart idea" and "Find a student who has time to be an effective tool". These responses provide clarity around the handful of negative comments returned regarding Katy's involvement in the program, and also support moving the curricular peer mentoring program to another term as suggested by the peer mentors in their group interview discussion.

As to Claire, there was very little data to examine, but all the comments returned were negative: "Saw them once, never again", "Tried once via social media, no response", "Never knew how to connect", "Wasn't accessible enough" and "I don't remember who they are". Respondents from ENGI A also noted "I didn't know this was a thing, thought they gave up after the first week" and "Never around, don't know how to contact, forgot we had one" and "Saw once for presentation and never again". These survey responses may indicate a lack of support for the program from Instructor 2. Students in ENGI C returned similar comments that indicated Instructors 1 and 4 could have done more to communicate the program to them, with respondents noting: "We weren't informed much about events or tutorials. I forgot we had a mentor" or "Didn't know we could [contact the mentor]", or "Underinformed on the fact that a peer mentor was readily available". This was not the case with Instructor 3, with one student directly noting "prof always referenced peer mentor to remind us which was good" but there was room to "Invite the peer tutors into class and labs more" or "get them more involved in labs".

The perception that the host instructors were not doing enough to incorporate the mentors into their courses was further highlighted by the suggestions the student respondents had about making the course more effective. As discussed above, many of them noted the need to use the mentors more in the course, but had specific comments for how the host instructors could do that, saying: "let the peer mentoring participate during lectures", "introduce them better and give them more time to talk", "highlight activities that the mentor is holding related to the course", "let the people know [about the mentors]", "involve the mentors more in course activities", "mention it more", "allow more time for mentors in class", "remind us more", "tell us more about it", "bring them to class more and help to figure out meeting times", "make the program more known" and further comments of a similar nature.

Given these trends, the majority of student survey participants indicated they experienced 'No Difference' in their course(s) with a peer mentor, or selected "Do not know" about the program and/or its effects. A small number of survey respondents reported 'Significant Benefit' from the program based on survey questions, and provided comments that aligned with the intentions and assumptions underpinning the program. A slightly larger number or respondents reported 'Moderate Benefit' from the program, and those that did understand the intentions and assumptions of the program and provided reasons for their rating. Two of the major reasons that students reporting ‘Moderate Benefit’ gave for their rating were due to (i) not feeling that they needed to use the program given their current academic performance, and (ii) not finding the program to be accessible and/or effective in meeting their needs.

That such a large percentage of the survey respondents noted they did not feel a need to access the program was at first glance surprising, given the courses have high failure and attrition rates (discussed in the following section). It is probable that the students who responded to the survey were the better performing students. Their self-reported current and anticipated grade point data did indicate this was the case, as the majority of students reported having current GPAs of 3.0 or higher. Higher performing students would also be (a) be more likely to have better attendance rates and (b) would have made it to the end of term, which was when the survey was distributed. Therefore, the survey comments indicating there was a lack of student involvement with the peer mentors is unsurprising when viewed from that perspective. Of course, the practicum component was not only intended to target low-performing students. Even if students chose not to connect to the program believing they did not need assistance from a peer mentor, the fact that they took away the message that the program was only for students who were struggling with the course material belies the intention of the pilot curricular peer mentoring program to build a learning community among all classroom participants.

The accessibility of the program cannot be conclusively determined without referring to the host instructor survey and interview data which will be discussed in the following section. However, some possible explanations for why many students reported feeling the program was partially or wholly inaccessible can be partially explained by data collected from the peer mentors as well as the researcher observations. For example, the comments many students returned about not knowing about the pilot program and/or the peer mentor assigned to their class correlates with data provided by the mentors about their experience with their particular host course instructors who either did not support the program and in doing so restricted peer mentor interactions in the program, or did not initiate involvement of the peer mentors into their course.

The student survey comments also, however, demonstrated the lack of sustained involvement on behalf of some mentors in their host courses. This seemed particularly true of Cliff, who was not consistently active as a mentor. It also was applicable to Claire, who was prevented from actively mentoring in her host course. Even Katy, who was supported by her host instructor and active in her mentoring practice, received comments indicating the students in her assigned host course were not aware of her or the program. It is possible this was simply due to the overwhelming number of students in the host course, making it unfeasible for her to reach all students.

In terms of whether the program had brought about institutional change, the student survey data would indicate that it did not. At least, it did not happen on a large-scale. There were indications from the data that students did benefit from the program. Survey respondents in ENGI C commented, “He [Cliff] was another option as a person to see to get advice about the course and about the engineering program in general,” or that he “Aided in giving a different perspective than the teacher”, that when Cliff spent time “helping during labs”, “going over practice problems” and “showing up during the lab slot" were helpful to them. Students also noted that Cliff "Helps me be more involved in the program and easy to access ways of improving it" or "I got to understand concepts that were covered too quickly during class".

Comments returned from ENGI B, noted: Katy "Created a more friendly, community-type environment", "The peer mentor was available to talk at a student to student level making the course more comfortable", "It helps me learn from their experiences", "Knowing there was someone I could ask questions was helpful" "It's nice to be able to have an older engineering student to ask advice", "The peer mentor made very clear what was expected on tests and assignments", "The Facebook [page] was helpful in getting quick answers to small problems" and they appreciated the study sessions she offered.

Clearly, the program did benefit the students who decided it was helpful to them to engage with it, but the effect was limited to a small group of students. However, the program would be of benefit to many more, as the historical records on student performance in the host courses show. The significant attrition rates in these three first-year engineering courses provide clear evidence of the difficulty students have being successful, and support the use of curricular peer mentoring as a pedagogical intervention that can address these problems, provided the program is better supported by the host instructors, more effectively embedded in the host courses, and more actively promoted by the mentors.

5.4 Investigating Institutional Change

There were three data sets examining what, if any, change took place in the engineering faculty. First, there was a survey administered to the general faculty and staff in the engineering faculty[68]. This survey was brief, asking them about their knowledge about the pilot curricular peer mentoring program, and whether they agreed with the intentions and aims of the program. Essentially, the faculty and staff survey was distributed to collect data on whether the curricular peer mentoring intervention had impacted persons outside the research populations closest to the intervention (mentors, mentees, and host instructors).

The Host Instructor interviews[69] expanded on this, asking more detailed questions about how the program had operated in their respective courses, what effects, if any, the program had, and their suggestions for future iterations of the program. This data also further characterized the intervention, providing additional insight into how the peer mentoring process unfolded in the host courses. Most importantly, the data collected from the host instructors helped determine the openness to change each host instructor exhibited, and whether their involvement in the program promoted or inhibited the larger institutional change objectives of the peer mentoring intervention.

The Senior Administrator interview was concerned with similar questions about the program's efficacy, but added an important institutional perspective. As I was (a) the program facilitator and seminar course instructor, and (b) a low-ranking member of the university hierarchy, obtaining an appraisal of the program through the view a high-ranking, established administrator was critical in linking the particulars of running the program to broader realities in which the program existed. This data set also provides an overarching summary of the program from inception to completion that compliments the

[68] Faculty & Staff Survey is available in APPENDIX I.
[69] Host Instructor Interview Script is available in APPENDIX N.

more intimate perspective on the evolution of program that I have as its designer and facilitator, by offering another layer to the analysis.

5.4.1 Faculty and Staff Surveys

The response rate from faculty and staff members was approximately 10% for both participant populations, and was therefore not representative of the faculty or staff research population. However, the fact there was such a low response rate does provide information in and of itself about the efficacy of the intervention in creating institutional change. Furthermore, regardless of the representativeness of the survey response rate, the data collected still offers some useful information. For example, all respondents were asked to if they were aware of the pilot peer mentoring program, and whether they thought it was a valuable intervention, and if so, what engineering courses they thought it would be best situated. Those who were unaware of the program were asked general questions about whether they were aware of courses in the faculty that used non-traditional teaching approaches (examples of which were given in the questionnaire script) and their opinion about such approaches to teaching. The following sections review the responses from faculty and staff.

5.4.1.1 Faculty Responses

Faculty members were invited to participate in an online survey asking them to respond to a series of questions probing their knowledge about the pilot course, as well as their general knowledge about peer-to-peer learning programs and non-traditional teaching methods. Additionally, they were also asked to comment on whether they thought a lecture-based only approach to teaching was effective, as well as if they knew of any courses currently offered in the Faculty of Engineering they thought might benefit from a peer-to-peer learning model or other non-traditional approach to teaching.

The faculty survey was sent out to all Faculty of Engineering academic staff via the engineering faculty member list-serv following the close of the academic semester exam period.[70] This timing was deliberately chosen to allow any faculty members teaching during the term to have an opportunity to respond to the survey request without the commitments of end-of-term activities and responsibilities constraining their availability. The survey link was sent once, and kept active for two weeks.

All respondents who responded to the survey completed the entire survey. The low response rate from faculty is disappointing, but may be explained by the following rationales: First, it is possible that faculty members habitually ignore list-serv messages. Second, it is possible that the faculty members who were emailed the survey request did not have the time to participate in the survey due to the demands placed on academic staff at the end of term. Finally, it is possible that faculty members were not inclined to participate in the survey as they did not perceive it as important to their work or worth their attention as it concerned teaching. Placing more importance on research instead of teaching is common practice among academics (Henkel & Vabo, 2006). The low response rate from faculty members may also support the larger hypothesis being explored through the logistics of offering the pilot course, which concerns the lack of support for, and engagement in, institutional change within post-secondary institutions.

[70] Refer to APPENDICES A, B, I, L for a copy of the faculty survey, consent form, and recruitment notice.

Survey respondents represented the spectrum of academic positions available in the Faculty of Engineering. Respondents included full professors, associate professors, assistant professors, and lecturers. They also varied in age, with the oldest respondent, a full professor, who reported being 60 years of age or older and the youngest respondent, a lecturer, who reported being between 30 to 40 years of age. The mean age of respondents was 48 years, excluding the one respondent that chose not to report their age. There was also a large variation in the number of years respondents had spent teaching. The longest tenure spent teaching was reported at 30 years, and the shortest was 1 year, with a mean tenure spent teaching of 14.9 years. Almost all engineering disciplines were represented as well, with only civil engineering not represented by the survey respondents.

5.4.1.2 Staff Responses

Staff members were also invited to participate in an online survey asking them to respond to a series of similar questions asked of faculty members probing their knowledge about the pilot course, as well as their general knowledge about peer-to-peer learning programs and non-traditional teaching methods. Additionally, they were also asked to comment on whether they thought a lecture-based only approach to teaching was effective, as well as if they knew of any courses currently offered in the Faculty of Engineering they thought might benefit from a peer-to-peer learning model or other non-traditional approach to teaching.

The staff survey[71] was sent out to all Faculty of Engineering staff via the engineering staff list-serv following the close of the pilot program academic exam period. Again, this timing was deliberately chosen to allow staff to have an opportunity to respond to the

[71] Refer to APPENDICES A, B, I, L for a copy of the staff survey, consent form, and recruitment notice.

survey request without the commitments of end-of-term activities and responsibilities constraining their available time to respond. The survey link was kept active for two weeks following the request for staff responses. The survey request was sent out once. However, there was a minimal amount of participation.

This low response rate is disappointing, but may be explained by the following rationales: First, it is possible that staff members habitually ignore list-serv messages. Second, it is possible that the staff members who were emailed the survey request did not have the time or the inclination to participate in the survey. Finally, it is possible that staff members who received the list-serv message were uncertain if they should answer the survey given their particular staff position. This rationale may be less likely than the preceding rationales due to the inclusive wording used in the staff survey request which attempted to pre-empt such a response. The low response rate from staff members may also support the larger hypothesis being explored through the logistics of offering the pilot course, which concerns the lack of support for and engagement in institutional change within post-secondary institutions. The respondents who did participate were demographically varied, holding different types of positions within the Faculty of Engineering, and various length of tenure. All respondents, other than one, provided responses to all demographic questions. None of these respondents indicated they had held other positions within the Faculty of Engineering, or any other engineering faculties within other universities. The mean length of tenure taken from the four respondents who answered the question about the number of years they had spent in their current position was 9.75 years. Some respondents held technical positions working within the engineering faculty labs, some were administrative staff members with responsibilities related to the faculty operating budget, international student recruitment, and general administrative activities.

Only one respondent indicated they had any knowledge of the pilot course that had been offered during the academic year. This same respondent did not answer any further questions. The remaining respondents did not record having any knowledge of the pilot program and were automatically redirected to a basic set of questions intending to gain information on their general knowledge of teaching methods and their opinion on teaching methods used in the faculty of engineering.

After their initial answer confirming they had no knowledge of the pilot course, one respondent failed to answer any further questions. Other respondents, however, indicated that they thought using a lecture-only format for teaching engineering curriculum was moderately useful. Some also indicated that they thought using a non-traditional (i.e. not exclusively lecture-based and/or lab tutorials) format for teaching engineering curriculum would be moderately useful. They were asked to choose their responses from three options: “Not useful”, “Moderately useful”, and “Very useful”. Most respondents also indicated that they were unaware of any courses within the Faculty of Engineering using non-traditional teaching methods. Although questioned if there were any courses in the faculty that they thought could benefit from a non-traditional teaching approach, none of the respondents provided a response. There were no comments offered by participants to the two remaining open-ended survey questions either. All survey respondents also declined an invitation to participate in a follow-up interview.

5.4.2. Faculty and Staff Survey Responses: Analysis

It is telling that there was such a poor response rate, and that only half of the faculty respondents indicated they were aware of the program, and only a third of these respondents could name at least one course in which the program was being used. There was also a lack of interest in the program, with only one respondent saying they would be motivated to teach a course knowing because it involved a peer mentor. However, respondents also indicated that "all first year and junior engineering courses", "ENGI A", "ENGI B", and "Mostly [first-year engineering courses], but some [junior engineering] courses also" would be the good courses in which to run the mentoring program. When asked if there were any courses in the department they thought would benefit from a non-traditional pedagogical approach[72], one respondent said, "Most courses", another identified specific courses, another said "I would like to see a real 'design' or 'problem solving" course. I don't think we have any, but that may be just my natural cynicism" and two did not respond. This indicates they saw a need for some type of additional support in the first-year engineering course, which could possibly support efforts for continued pedagogical change in the faculty. The latter comment on 'problem-solving' also highlights some of the issues discussed in this study around the rote learning approach to engineering pedagogy.

The faculty respondents that indicated they were not aware of the pilot curricular peer mentoring program were asked if there were courses they knew of that used non-traditional teaching methods (i.e. not exclusively lecture-based and/or lab tutorials) in the

[72] The 'traditional pedagogical approach' was defined as 'rote learning' and a list of 'alternative teaching methods' was provided in a hyperlink to survey participants. It is available in APPENDIX Q.

Faculty of Engineering at Maple University. A minority of respondents could identify courses using non-traditional pedagogies, and when asked if they thought a lecture only format was useful for teaching engineering curriculum, over half the respondents indicated it was “Very Useful” with one commenting “Lectures, when well done, represent a very concentrated and efficient way to expose students to ideas and information”. This possibly supports the arguments made in this study that certain expressions of engineering pedagogy and discourses promote transmission modes of learning.

Finally, when asked if a non-traditional pedagogical approach was useful for teaching engineering curriculum, a minority of respondents said such an approach was “Very Useful”, most said it was “Moderately Useful” and one did not respond directly, instead saying “If we had the time in advance then this could become very useful. But is the University willing to invest TAs, funding and resources in those? For the moment, the answer is negative”. This comment highlights the neoliberal effects on university education: faculty see a need for non-traditional teaching methods and better resourcing but do not feel those resources are there. This is compounded by the view that pedagogical change may be counterproductive if poorly implemented, which was offered by another respondent to this question who said, “I think there are probably some ways to enhance the curriculum with non-traditional approaches, but I feel that such approaches are more likely to be non-productive if not well done”.

Unfortunately, there were very few staff members that submitted survey responses, and none of them had fully completed the survey. Those who did answer questions chose safe responses. Therefore, the staff data set, although small, demonstrates their tentativeness to answer these questions, which is an indication of their position and power within the university hierarchy as they, presumably, would not generally comment on teaching.

What was helpful about the faculty and staff survey data was the fact there was such little data collected. The low response rates indicate a lack of engagement with the larger institutional activities taking place within the Faculty of Engineering at Maple University, and/or a lack of communication about such activities, and/or a sense that such activities are unimportant or unconnected to individual faculty and staff members. This sense of disengagement within institutional change processes is well-documented in the change management literature (Carter, 2013). The need to effectively communicate and involve all members of an institution – even those on the periphery of the change taking place – is a fundamental goal of institutional change because change does not take place in a vacuum, and requires the support of multiple actors within a network, and in turn can benefit those actors.

For example, one of the staff respondents identified her role as a person who worked with international students in the engineering faculty. If she had been more aware of the program (and provided the program became established), she could have used that information to provide additional incentives for international students to study at Maple University. Other respondents identified their roles as Lab and Research Technicians, and could have provided additional support to the undergraduate students they worked with if they had known it was possible to direct them to a curricular peer mentor. Even respondents who indicated they were involved in administrating faculty budgets, could benefit from engaging with the pilot peer mentoring program by seeing what operating expenses could be realistically reduced if the curricular peer mentoring program was to reach the critical mass necessary to reduce student reliance on out-of-class supports funded out of the faculty's operating budget.

In summary, the lack of awareness about the program exhibited by the low response rate and the survey responses that were submitted, was not surprising as the pilot curricular peer mentoring program development was limited to a handful of faculty and staff members, was added to the engineering calendar at last minute, and was not effectively communicated across the engineering faculty media platforms. However, the potential for the program to benefit persons tangential to the program still exists. The following section discusses the host instructor response to the program, and touches on the actual and potential benefits of the program, while also highlighting what could be changed about the program to improve its positive returns.

5.5. Host Instructor Interviews

The host instructor interviews featured an open-ended questionnaire that were built on the faculty and staff survey questions, and further assessed the program from the standpoint of the specific faculty that it involved. First off, they were asked to state in which engineering department they belonged, the number of years they had spent teaching, the number of courses they were currently teaching, and how many hours a week they spent preparing for their course(s). Like the student mentees, they were also asked to estimate the time they spent each week in hours at work, volunteering, or caregiving. This was an important question to ask because it allowed the researcher to gain a perspective on the amount of time available to the host instructors to be actively engaged with the additional responsibilities of hosting a curricular peer mentor.

They were then asked 12 open-ended questions about the pilot peer mentoring program that asked their opinion about its effect on the engineering learning experience generally, the social and academic aspects of learning for the students in their courses, and its usefulness as a pedagogical tool. Host instructors were also asked if they would recommend peer mentors to their colleagues, if there were any courses they think would benefit from a peer mentor, and if having a peer mentor available to be assigned to a course would incentivize them to teach that course. They were also asked specifics about how they worked with and utilized the peer mentor assigned to their course.

Instructors 1 and 4 elected to do a group interview, as they were both the instructor of record for the ENGI C host course, wherein Cliff served as a peer mentor. Instructor 3, the host instructor for ENGI B, in which Katy served as a peer mentor, met with the researcher one-on-one. Instructor 2 who was partnered with Claire declined to be interviewed. A summary of interview notes, as well as direct quotes from the host instructors, are discussed below:

5.5.1. Interview with Instructors 1 and 4

Instructors 1 and 4 were amenable to being interviewed, with both requesting a joint interview. Professor Instructor 1 spoke the most, with Professor Instructor 4 adding comments of his own sporadically. Mainly, Professor Instructor 4 confirmed what Instructor 1 said, or just repeated what was said. Given Instructor 1's established academic seniority compared to Instructor 4, I was not surprised by Instructor 4's initial request for a group interview or his deference to Instructor 1 during the interview.

This relationship possibly speaks to hierarchical orders in academia. Academic hierarchies can be barriers to change within universities as persons who are not comfortable speaking or acting for themselves find it difficult to lead change. It is possible, however, that they can carry out change if so directed. For example, in this study, Instructor 4 was responsive to the change being enacted by the pilot program because Instructor 1 also supported it. Therefore, this interaction between a powerful person and a less powerful person also suggests that hierarchies might not be barriers to change if those who are in power embrace change and encourage others to change.

Although Instructor 1 was not opposed to the pilot program, he was not an avid supporter of it, and therefore the change that took place in Instructor 1's and Instructor 4's host course was not significant. Instructor 1 made little effort to interact with Cliff, and did not attempt to follow-up with him after the introductory meeting. Essentially, both were open to Cliff acting as a mentor in the host course, but indifferent about whether he meaningfully participated in their course, with them, or their students. They did not prioritize his presence in the course, and did not seek him out or direct their students to him. This lack of engagement in using Cliff as a resource for their teaching, and student learning could be the result of many factors: lack of time, workload, etc. It could also be a result of lack of buy-in to the pilot program.

When asked about the overall effect the peer mentoring program had on the Maple University learning experience, the instructors were noncommittal, vaguely speculating it was a positive intervention although unsure of whether Cliff was involved with the students in the course. When pressed for a more concrete assessment, Instructor 1 said, *"No idea because no students talked about it with me".* His follow-up comment suggests he was seeking to justify his lack of awareness or involvement in the program, saying: *"In a way a professor is not really to be in the loop".*

Instructor 4 agreed with Instructor 1 about not knowing whether the pilot program had an effect, but did not have a similar justification for his lack of awareness or involvement in the program. Instead, Instructor 4 commented he was *"Not really sure actually if the mentor has to interact with the instructors or not".* This comment suggests he was uncertain about the role of the professor in the program, which is important feedback for future iterations of the program. However, it also provides insight into another aspect of institutional change: uncertainty can prevent change. People need to have very clear directives about the changes taking place, making it easier to understand what is happening and how to respond.

When speaking about the role of the mentor, Instructor 1 noted that Cliff's participation was uneven – even from the beginning of the program. This is an issue, he commented, because the mentors need to be there from *"day one so students get the imprint really early".* Instructor 1 offered another comment indicating his belief that the instructor is a passive participant in the mentoring process, saying, *"It should really be emphasized that the mentor needs to speak with instructors".* This comment demonstrates his perception that the ownership on the program rests solely on the mentor, and he emphasized that the students selected to do the mentoring must have a real motivation for being a mentor, and that “*They are really happy to go in there with an outgoing personality and walking right up to students and saying ‘Hey!’.*

Instructor 4 did not disagree or endorse Instructor 1’s comments, but offered his own perspective on the role of the mentor in terms of the actual ‘work’ the mentor is expected to do, which he believed was to contribute to the feedback students receive. This prompted Instructor 1 to offer more targeted comments about the mentoring role, saying *“There are two sides to the course, so having a mentor might lead to a bit of confusion. They need to be aware of what assignments are and closer to it to be comfortable and effective in the course. Having later experience with the same material would help the mentor be better at supporting students.”* He also said that *“In the future, having two mentors for ENGI C would be good to help cover both angles of the course. Cliff was a mechanical engineering and not as close to the material.”* Instructor 4 added that there needed to be a higher ratio of mentors to students for the intervention to be more effective.

These comments are helpful, because the show these instructors notice the benefits of the mentoring program, while also indicating barriers to its implementation. Encouragingly, after listening to Instructor 4, Instructor 1 began to recognize that there was a benefit to the program, but that was conditional on whether he had the ‘right’ mentor. It is understandable he would want to have a mentor with the same background in the course material, but all the mentors have done all the junior courses so have the necessary experience. Furthermore, for a mentor to be aware of and comfortable with the assignments is not a result of having advanced studies in the course subject. It is a result of effective communication and information from the host instructor about the course, course assessments, and their general expectation of how the mentor can assist in supporting students.

It is interesting to note, that despite all these potential issues that Instructor 1 pointed out, he also expressed a desire to have two or more mentors in future iterations of the course. This supports my analysis of him being open to the program, but not especially engaged with it. While Instructor 4 did not hold similar views as Instructor 1, he seemed more supportive.

Despite his detractions about the program, when Instructor 1 was asked if he would be motivated to teach a course with a peer mentor, he indicated he would, saying *"It's a positive element to teaching the course".* He offered a caveat, however, that it not be the deciding factor in whether he would teach a course. He goes on to say, "As *an instructor it feels good to be able to tell students that there are resources that can help them succeed, sometimes it's really hard as an instructor to help students who are struggling, so why not talk to the senior student that can help you with study tips etc."* He also noted that it is helpful to have a senior student operating as a mentor in the course because they are closer to the material. Instructor 4 agreed, and they both said they would recommend hosting a peer mentor to their colleagues.

Instructor 4 and Instructor 1 also commented that having a mentor in junior courses in general would be helpful, *"In general, for sure the junior courses, and probably there aren't any first year courses that wouldn't benefit. [Junior engineering], there would be value there. [After that] students have a cohort and wouldn't really need the mentor at* *that point. Plus, in their first interaction with their chosen discipline there could be a lot of value there".* Instructor 4 added to this, saying: *"Some subjects might be useful to have a mentor, but once again it depends on the types of questions they are getting from the students".* Instructor 4 noted that the questions Cliff got were about selecting engineering disciplines, which had nothing to do with the course. Instructor 4 asked, *"What questions were about ENGI C?"* Instructor 1 responded to him, however, saying, *"In some ways that's a role the mentors are playing – advice on all sorts of things around the course, not just about the course. I think that the idea is to link mentors to courses, but in some ways, you could even have mentors in [junior courses] that aren't just there for a specific course, are there for a broader perspective too."*

Observing this interaction between Instructor 1 and Instructor 4 was helpful, as it showed them both questioning the intention of the program, and Instructor 1 realizing that the intention is to have them mentor to offer a broad level of support – not only discipline specific support. On one hand, he does not want to be inconvenienced by the program (for time, workload or other reasons) and does not identify a need to change *his* usual instructional role. On the other hand, he can identify the curricular and non-curricular benefits of the program, and the capacity of the program to assist him in his instructional duties and his students in their learning. However, Instructor 1 and Instructor 4 did not do much to capitalize on these strengths. They did not seek to interact with Cliff, instead waiting for him to initiate contact. They spent a total of 2 hours planning and interacting with Cliff over the entire course, most of which was during the introductory meeting and the rest via email. They never met with him outside of class time to help plan his participation in the course, and they did not communicate his role in the course to their students.

Therefore, it is unsurprising that they reported no positive affect to the social, emotional, or academic learning in the course due to mentoring, and when asked what peer mentoring activities or roles were most beneficial to the learning experience this term, they could not provide any comments, saying the question was inapplicable. This prompted a follow-up question about what they would ideally like to see the mentor do in their course, and Instructor 1 said one thing Cliff was doing and should continue to do was being present in the lab session, and that and when he was present he was going around speaking with each group. *"Getting a face-to-face contact, and being able to create the interaction is the most critical part. [That] happens best in labs because they are smaller." Instructor 4* agreed with him.

When directly asked what they as instructors could do to improve the efficacy of peer mentoring in their course, Instructor 1 noted he and Instructor 4 could have done more to promote the program, *"I guess just in the ways that we communicate with the students – just emphasizing the mentor and their role which I definitely didn't do because I didn't know what was going on with Cliff".* He also says*, "I imagine the Facebook page is good way to communicate because its an instant interaction tool."* Instructor 4 nodded in agreement.

Ironically, these interviews highlight the issue of disengagement as a barrier to the effectiveness of the program. When asked if they think peer mentoring can be an effective pedagogical tool for university engineering undergraduate education, Instructor 1 said, *"Maybe Cliff was more effective than I know, but these things can only be as good as the people doing them … I think the student engineering conference derailed Cliff from the beginning of the term. It's the soft things that end up falling off people's plates."*

The themes brought up in the interview responses from Professors Instructor 1 and Instructor 4 confirm the unevenness of Cliff's level of involvement in the program, as well as the student survey data from the students in ENGI C who were unaware of Cliff's presence in the course. The student survey data also indicated there was little communication about the program from the instructors which they themselves agreed with when discussing how they could improve the facilitation of the mentoring program in their respective course sections. The suggestions for what courses would benefit most from the program support its continued existence in the first-year engineering courses, as well as junior engineering courses – which was indicated by the mentors as an ideal slot in which to provide curricular peer mentoring – given this is when the students first enter their discipline-specific engineering education.

Generally, the interview data serves to further confirm what an ideal curricular peer mentoring model would look like (i.e. communicative, involved host instructors that also allow the peer mentor freedom to act, and a peer mentor that takes initiative within the course and is also familiar with the host course material because their discipline area is an evolution of the course material). The data also spoke to the barriers preventing the realization of that ideal (i.e. uncertainty about how to utilize the program on the part of the host instructors, and a peer mentor who could not be present enough and/or at the right times and/or in the right spaces for the course they were hosting).

In terms of the larger assessment about institutional change, Instructors 1 and 4 were clearly not averse to making changes, albeit they were not ‘change champions’ either. Their responses indicated that the intervention was not successful in making significant institutional change, but at the very least it opened the door for that change by introducing a new teaching and learning concept to two instructors in the engineering faculty. The following interview data from Instructor 3 adds further insights.

5.5.2. Interview with Instructor 3

Instructor 3 demonstrated an entirely different attitude towards the program. He was engaged in the program, and excited for its potential. His enthusiasm was put into action by his consistent, regular, engagement with Katy, his peer mentor. He also communicated the existence of the program to the students in his host course, and actively built Katy into his teaching practice and course instruction. His enthusiasm, however, did not cloud his judgement of the program and its efficacy, nor his role in making the program effective. He noted that he’s unsure if the program had a huge effect, but did think it was a good idea and with further tweaking it could be highly effective. Part of what would need to happen in future iterations of the program would be an increased clarity around the program objectives amongst the host instructors and mentors. He commented that he was not clear on the program objectives, saying about the curricular peer mentoring program *“I’m not sure what it was for, Katy didn’t know what it was for. So, I’m not sure if it had a lot of impact on the students. I think it could, and it probably had some.”* This is important feedback, because Instructor 1 and Instructor 4 also expressed a lack of awareness over the intentions and objective of the peer mentoring program. This suggests that in the future, more time would need to be spent communicating the program’s purpose and objectives at the introductory meeting, and following up on that throughout the semester.

Interestingly, the lack of clarity on the purpose of the program did not cause Instructor 3 or Katy to disengage. Instead, Instructor 3 noted that *"Katy would try to show up and model good student behaviours in the class. I hope that had a positive effect."* He found her available enough throughout the course, although noted "*Katy' availability decreased half way through the term although she did prepare me for her absence. In some ways, she was more available than the students would take her up on."* Until that point, they met 30 minutes a week at a regular time, and he estimated they spent 5-6 hours actively planning her involvement in his course. He also recognized there were actions he could take to further integrate the mentoring program into his course, such as remembering to alert students to any ongoing study session or workshops Katy might have hosted, such as the PAR workshop.

When offering further commentary on how he himself saw his role in the program, he saw himself engaged in an active, participatory, collaborative process with Katy. Importantly, he did not find the program to be onerous. Instead, Instructor 3 saw the benefits of the program and recognized his role in actualizing those benefits in his course. He commented that the time commitment was manageable, even though he was a first-year, tenure-track professor. He did not find the program hindered his teaching duties, and thought it would be even more useful to him in the future. Commenting that he would opt for a course with a mentor over one without a mentor, and that "*It didn't take a lot of time* *out of me, and afforded me an opportunity to know about students and where they get help, etc."*

Supporting his students was clearly important to him, and he saw the mentoring program as a tool to do this, saying "P*art of the reason I was so excited about the peer mentoring idea was being able to get some feedback from the students, that's what I wanted. Outside of tests and the few keeners I hear nothing from them except from the exams and the CEQs".* He saw the program helping the students in his other courses as well, because the mentor acts as a go-between between the instructor and the student, communicating issues his students are experiencing but are not confident speaking him about directly. He realized this support is important, although he commented that *"Ideally students should feel comfortable to come and speak with me during office hours. Ideally, I would be their first point of contact, but realistically if there was someone else they could go to who could encourage them towards me or the help centre that's good too."* Furthermore, he noted that the mentors can model good student behaviours, which he believed had more impact than him as an instructor admonishing them, saying "*Some of the first-year haven't quite figured out what to do to do well. When I, the teacher, tell them if they want to learn this they need to practice it, they will blow it off but listen more to another student."* Finally, he also noted the importance a peer mentor can have on motivating students or giving them tailored feedback.

Although Instructor 3 indicated he was unclear of the objective and purpose of the mentoring program, his comments demonstrated an accurate understanding of its overall intention to support students in their learning. Not only did he note the usefulness of its feedback mechanism for supporting students, as well as the mentor modelling helpful student behaviours, and providing links between student and instructor, he also realized the role the mentor can play by being an exemplar of a successful engineering student, which is captured by his response to whether he thinks peer mentoring can be an useful pedagogical tool for engineering undergraduate education, saying, "*I suspect it definitely could be, and it probably even was. It could be more useful, it could be very, very useful, and particularly if there was a stronger sense of the mentor being someone the students could see themselves being in a few years. I want students to look at Katy and think they could be her in the future."*

His comments about the 'mentor being someone the students can see themselves being in the future' are expanded on throughout the interview, and like Instructor 1 and Instructor 4, centre on the mentor being a senior student in the discipline area of the host course. He believed this held true regardless of the commitment of the peer mentor to their mentoring role:

> *"I think Katy was committed to the thing and the student outcomes and stuff, I think the thing that would have been more helpful would not to have someone who had background in the particular material BUT someone who had gone on in the sub-discipline. Katy wasn't in a position to explain that. For example,* Instructor 2's students [practice a specific skill]*, maybe it's not the primary thing that they do but if it enters in their later stuff at all then it motivates students to realize it may not be their primary focus, but it will be useful someday.*

> *Not that I'm looking for someone with technical expertise because we have me, office hours, TAs, but it's more about having someone who can say, 'yeah, yeah, I did that course and it is/is not important in the real world and later work'. As opposed to, 'this is a hurdle and it's in first year and you have to get over it'.*
>
> *But it's still just a hurdle that you get over, and that's not what Katy is telling students, but it's her experience and that's an inference that students could naturally draw when they ask her questions about whether she does [ENGI B work now]. It comes down to 'what do we mean as a peer?' Someone who is engineering who did the courses you did, or someone who is going to go on and have the same engagement as you is in the field."*

Similar to Instructor 1 and Instructor 4, Instructor 3 believes that the ideal fit between the host course and instructor and a curricular peer mentor, is a mentor who has gone on to do senior level studies in the host course content and intends to continue as professional engineer in that discipline as well. He recognized that part of the mentoring role is to make space for informal interactions, which he indicated in the above quote where he rhetorically asks, 'what do we mean as a peer'? Clearly, for him, a peer mentor would be most effective if they were a senior student studying the same discipline as the host course, saying his course "*wasn't a great fit for Katy because she couldn't speak to the general ideas around [the ENGI B discipline] in future studies or work because she's a process engineer."*

Despite this clear preference for a mentor in his disciplinary area, Instructor 3 did not view his mentor as an unpaid teaching assistant. This is an important piece of interview data, because it demonstrates that Instructor 3 understands the role of the mentor as it is meant to be: a peer support system, not a substitute for professional teaching staff or paid graduate teaching assistants. This is critical, since the other instructors interviewed seemed to find the distinction difficult. Their interview comments indicate they saw the mentor as additional teaching support. Instructor 3 correctly identified that one of the most important roles of the peer mentor is to provide context for the academic work that students are doing in the host course – helping them link that to their future studies and future career – and thereby perhaps developing an intrinsic motivation to succeed in the course *or* realizing they may be unsuited to a particular engineering discipline.

This is critical information for future iterations of the program in an engineering faculty, because it offers a compelling reason for linking peer mentors to specific courses based on their engineering discipline. The information from Instructor 1 and Instructor 4 indicated the link was important to assist pupils in the course content. However, this would not be a compelling enough reason for pairing certain mentors to certain courses when all mentors will have completed all junior courses. Instructor 3, however, offered a convincing justification: mentors can better fulfill their functions as a source of informal information about engineering studies and professions.

Clearly, Instructor 3 held a positive view of the program. He also had suggestions for its improvement. For example, he thought students would engage more with the program if the peer mentors held a set schedule of mentoring activities, noting "*"It could be useful if there was more predictability from the students' perspective" so they would know when they would see Katy, so they could prepare questions. "Obviously, it would be great if she* *could come to all lectures and labs"*. These comments are clearly supported by the student survey data, as respondents indicated they were either unaware of the program or unsure of how to be involved in it. Therefore, going forward, having an established and well-communicated schedule of mentoring activities would likely increase student participation in the program.

However, even if Katy had a more regular schedule of interaction, Instructor 3 questioned whether it would make a meaningful difference, noting that "*Katy would curate and moderate a facebook group, but students didn't talk to her much over it,"* and he was "*not sure if it picked up much running into the final, but if we had found a way to get students more engaged the facebook group it could have been more beneficial"*. Again, these comments are supported by the study survey data that found many students indicated a disinterest in the program, or did not identify a need to participate in it. Although Instructor 3 thought the PAR workshop was helpful, he noted the lack of student participation in the event, which was also borne out by the student survey data. Finally, he commented that "*I suspect that just being there in lectures could have been beneficial. Showing up for labs wasn't particularly helpful but could've been. Katy would come to some labs and wander around, but it could be more useful because it could provide an opportunity to have unfocused, unprepared interactions."* This response supports my recommendation that the mentor be clearly and regularly embedded in the lectures and labs, as it makes the mentor immediately visible and available to students.

Instructor 3's comments on how to improve the program also highlighted some important aspects of traditional engineering cultures and discourses, which he himself identifies:

> *"In engineering, there are a number of students who go into engineering who want to have their stereotypes confirmed and just want to learn what they need to get a job. I'm here because I'm looking for a linear path from here to the job and I'll do whatever stuff I need to do to get the job."* He asks of himself, *"How do I break those molds? At the end of the day a lot of it comes down to their own responsibility and ownership of the material."* [Pretending to speak to his students] "*You are adults now, but you need to own it yourself. It's my responsibility to give you a mark but it's yours to earn the mark and show me you know the material."*

Instructor 3 is hitting on a crucial factor about the pilot program and its relative inability to affect change in the Maple University engineering program, which is the unwillingness to change demonstrated by most actors within the engineering program – which extended to the students it was intended to support. Outside the handful of first-year engineers that engaged with the mentoring program in class or labs, or via social media groups set up by the mentors, or the PAR workshop, there was a lack of meaningful interaction with the program. Instead, students were solely focused on meeting the requirements of getting a job and confirming their personal stereotypes of engineering. This is not only indicated by Instructor 3, but also by the student survey data that shows most students did not see value in the program. Unsurprisingly, those who did find it valuable were the students who chose to engage with the program. For example, the verbal feedback from students at the PAR workshop was overwhelmingly positive. Much of that feedback was centered on being able to understand the context of their studies and discipline area.

Instructor 3 lamented this lack of student engagement, and commented that the mentor-to-instructor feedback mechanism sometimes returned disappointing information. For example, he found "*Katy did give me feedback but most of the feedback was about the fact students hadn't clued in they need to put effort in. So, the feedback was accurate but not what you would hope it to be. You know, it sucks. Certainly, I was encouraging them to be actively involved in owning their own material, so was Katy, and it's not her fault – she gave me accurate feedback but not what I was expecting. Katy was doing her end of it but getting feedback from these students is like getting blood from a stone.*"

Although this was disappointing for Instructor 3 to realize, his response further supports the conclusion that change is difficult, and can be particularly hard in engineering programs, where there is a resistance to change at all levels of the hierarchy. He offered an insightful opinion about this, when speaking about a potential programming change he is looking to make in his first-year engineering course,

> "*One thing we're thinking about in ENGI B with Project X* [a new university teaching and learning program] *is if there's some way you can flip the classroom in ENGI B. Would it be useful or just the latest buzzword in education? If we did it that, it would be a radically different environment for the mentors but also a lot more opportunity for the mentors to be involved. If we flipped the classroom there would be more time in the lab and less or no time in the classroom. If we had more time hanging out in the lab and doing things, then that would provide more opportunity for mentors to be there and be useful. It might find a way to make the existing labs and lectures more engaging. It's tough making changes with a first-*

year course as being repeated three times consistency is paramount and they are risk-averse because if you make a change and it's not successful could lead to negative outcomes for students."

This comment is at the heart of the matter: change is difficult; change is risky. Instructor 3 was willing to take the risk, and he was prepared for difficulties. Although he did not observe a negative impact on his students and their learning, Instructor 3 realized that when change fails it may negatively impact the people (in this case, students) it is meant to help. I think this is a critical comment, even if it is tangential to the peer mentoring program: the mentoring program did not have a negative effect on students. None of the survey responses indicated a negative effect, interview data from the instructors did not indicate they observed a negative effect, and data collected from other peer mentoring programs did not indicate negative effects to students and their learning. However, what Instructor 3 was speaking to in his comment, which was additional to the interview script and unprompted, is the perception people have of change being negative. Instructor 3 saw the opportunities, but others like Instructor 1 and Instructor 4, saw the consequences.

In conclusion, the information provided by Instructor 3 is richly detailed and thoughtful, and adds to the host instructor data set by discussing what engineering students are like to teach, what an ideal fit between a curricular peer mentor and host course would be, as well as highlighting the thought and consideration that needs to go into making changes to teaching and learning programs. His profile of engineering students not only agrees with the literature about the engineering discourse described by Riley (2008) and Cech (2014), but also helps explain some of the negative student survey responses about Katy (either they did not perceive the program as part of their linear path, she challenged their stereotypes about mentoring, or her subject area was not aligned with their own). His discussion of first-year engineering students being difficult to teach, especially his comments about how they do not realize that being successful means putting in work now that they are in university-level studies, also underscores the student survey responses about not engaging with the program because they did not believe it was helpful.

A particularly poignant contribution was Instructor 3's comments about bringing about pedagogical change in a university department. Knowing why you are making a change, taking the time to make that change, preparing for the change while still being open to unstructured and informal processes, and making sure not to change for the sake of changing, are all components of successful change management practices (Anderson, 2011). The next section discusses institutional change further, by examining the interview data sourced from the senior administrator, Professor Jackson.

5.6. Senior Administrator Interview

Professor Jackson, the senior administrator responsible for overseeing the pilot course was formally interviewed after the pilot course finished. This interview followed the same line of questioning, and employed the same open-ended format, as the interviews held with the host instructors. It was a semi-structured interview that investigated whether Professor Jackson thought the curricular peer mentoring intervention was valuable, met the concerns of the faculty – specifically its first-year introductory program, and whether the faculty was amendable or hostile to change. The only questions omitted from the host instructor interview script were questions 2, 5, 6, and 7, as these questions were about being a host instructor and teaching in a host course. Furthermore, two additional questions were added to the administrator interview script, asking "Do you think engineering has a diversity and/or inclusion problem" and "How ready is the Faculty of Engineering for change?"

When asked how he though the curricular peer mentoring program had affected the Maple University engineering learning experience, Professor Jackson noted that it clearly affected a small number of students during the delivery, but there were no lasting effects of the program within the larger faculty. His assessment of its effects was not only confirmed by my observations but also the host instructor interview data, as well as the faculty and staff survey data. He did, however, comment that the program had the positive effect of kick starting the faculty into thinking about mentoring.

He would recommend hosting a peer mentor to the professors in the engineering faculty because it *"Provides an engagement piece"* and encourages students to learn. Having a peer mentor would help students make constructive connections to their learning experience because *"All that students hear is 'You need to do it' instead of positives* [i.e. the benefits of learning]*"*. In terms of which courses he thought would be best suited to hosting a curricular peer mentor, Professor Jackson noted that first-year courses were important to target, as were the additional courses that comprised the first-year engineering program, but which were not housed in the engineering faculty. He said of the later courses *"Once they move into their cohorts there is more natural mentoring or learning due to the nature of the cohort"* and therefore did not think there was as much of a need for mentoring past the first year of the engineering program. This was interesting, as it directly contradicted what the mentors, mentees, and host instructors thought about where to best place the program. Given the initial program set-up was constricted by (a) Professor Jackson wanting to place the curricular peer mentoring intervention in the first-year courses and (b) the constraints of the engineering course structure in allowing the pilot to run in any other years, his comments that it was *"less critical"* to implement the program past the first year was expected.

When asked if he thought the program could affect the social and emotional aspects of learning for engineering students, Professor Jackson said *"Likely, students will talk a little bit about their feelings, and sense of where they are in life, and this gives the mentors a chance to talk about certain things that are non-academic but still helpful and relevant."* He also noted how the mentors could help model useful behaviours for interacting with their peers and future colleagues, as well as how to find a balance in their engineering studies given the high demands placed on engineering students at all stages of their education. He also commented about the difficulty of getting students to engage in a dialogue about the socio-emotional aspects of learning and university life, *"The engineering student profile is very competitive, confident. These are all good things, but they tend to mean you have a student who thinks success is something you do as an individual and they don't look for help because that's somehow perceived as weak. Students of that mindset can fall through the cracks."* He follows this up by noting that *"There will be students who don't seek mentors, and if someone doesn't look for help you can never help them."*

When asked if he thought that curricular peer mentoring activities could enhance the academic learning in an engineering course, Professor Jackson said, *"It can"* but to do that the mentors needed to be good listeners and not interested in holding power over the mentors, and in turn the students needed to be willing to learn, and communicate with the mentors. He again notes that in his administrative role he consistently *"Has students fail miserably and never even reach out to all the supports available to them"*. Some direct tutoring could be helpful, but he thought this was less important because there are already a lot of tutoring supports in the faculty. Instead, the focus should be on how to study and how to approach being a successful student. The activities he thought would most benefit the undergraduate engineering learning experience, was *"getting the dialogue going"* and *"maybe activities that can help with that by creating a safe space to talk"* as sometimes dialogues were more likely to happen outside of class where there were no authority figures and hierarchies. This comment supported my observations of how the mentors and mentees interacted during the PAR workshop, with both the senior students and first-year students having an open, unregulated and informal discussion about what they liked, disliked, and honestly thought about the engineering program, faculty, and staff.

He then commented on what he thought he could do as an administrator to better embed curricular peer mentors in the engineering program. Professor Jackson noted that it would always be a challenge at the individual instructor level to get support for such a program, although not insurmountable. He mentioned some instructors as difficult to work with in terms of change initiatives, and in general about the difficulties of trying to lead change among engineering faculty who are set in their ways, and either aggressively or passively resist change. He also talked about how important time was for introducing a new faculty program, and that there were many external forces that dictated the pilot program roll-out. For a program to be implemented, he said "*We needed to create conditions to have it be wanted, requested, and sustained.*" Furthermore, there were logistical challenges to getting the program up and running, and to make it work next time there would need to be higher mentor to mentee rations, and better buy-in from the host instructors. That said, he commented as Instructor 3 had, that *"there was no damage done".*

Despite the barriers to implementing the program in its ideal state, Professor Jackson still thought that curricular peer mentoring was a useful pedagogical tool for university engineering undergraduate education. *"Absolutely,"* he said when asked, *"It can be a challenge to implement, but this is probably why it is so valuable."* He said of the first-year engineering instructors specifically, *"Just because there's a shell shows you need to get in there! Get them able to communicate, and work together, and share challenges."* He also thought the program provided "*an opportunity for the mentors to develop their leadership and communication skill sets because this helps you reflect on that [leadership and communication skills] and that [reflection] is where learning happens*."

When responding to the one-off question posed to him as an administrator, and which was not posed to any of the other research populations, Professor Jackson said engineering had a diversity and inclusion problem, *"Both as a profession, in engineering schools, at Maple University specifically, and at the societal level."* When asked about the response to international students, he commented that Maple University did not align itself with the Canadian federal government push to use international students to bankroll university operating costs, because the tuition was low, and the university was well-funded, and the number of international students accepted to the program were based on the number of international students the faculty could support. Recruiting students with the right credentials and abilities was key he said, especially in terms of them having a successful co-op experience. He also noted that there was a lot of cultural diversity among the engineering faculty members as well.

The more fundamental diversity issue, he said was with gender. He said it was difficult to deal with the gender issues because *"Even for those on ahead of the curve, or at least on the right side of the curve, there is so much embedded in the engineering journey that is typically male, it's difficult to see what it would be like for women going through the process."* As someone with close female family members that were engineers, and generally a champion of female engineers, he noted that he still had epiphanies about the female engineering experience when attending workshops on gender diversity in engineering education.

He also mentioned Indigenous students, and their experience in the program. He said, "*The Aboriginal question is important. Maybe the issue is to get them to want to be engineers. However, there are a number of students in the engineering faculty that have an aboriginal background, and don't want to be identified as such. Possible reasons for that might be stigmatization but I'm not sure. Perhaps it's more that people want to be identified by their engineering practice not their ethnic status."* He was clear that bringing more Indigenous youth into engineering was important, and perhaps offering an additional year for first year Indigenous university students to complete the engineering program entry requirements for entry into the junior engineering courses would help facilitate their successful entry into the undergraduate engineering program.

To the other one-off question about institutional change asked of him as an administrator, he said that the faculty members *"Were a real mixed bag, all over the map. From off the scale inappropriate and unacceptable, to brilliant*". Again, he noted that change was "*all about timing"* that "*there was a tipping point"* at which point change could happen. He said *"I would like to see change, but I have to choose the right time. When there's a majority in favour of the change, then the few dissenters are ignored"* He said the faculty was in a good place to go through change because there had been significant turnover among the faculty members and most faculty were now new, or at least new to Maple University, meaning there was less entrenched institutional practices preventing change.

He continued his comments on change as they applied to the university, *"For all the great things universities should be…readiness for change is not innate or part of what people bring to a university as faculty members because their training and history is pretty traditional".* He said this sense of tradition is most noticeable among professors coming from cultures where *"the professors are god-like and people (and students) are expected to just have to sit and listen to them quietly".* In that sense, he said there was a cultural diversity issue among some of the professoriate because they did not understand why that model did not work and was not appreciated. He said of this, *"Some people resist change because they are ignorant, not because they are actively hostile."*

He continued his comments about the need to change among a largely traditional professoriate, asking, *"How do I stay relevant when you don't have to come to classroom* *to learn?"* That there is less fear about technology among engineers is helpful, he says, but the fear is not really about technology as much as it is about *"the unknowns, about what it means to educate beyond just content delivery. The shifts in accreditation towards learning engineering education outcomes instead of engineering topics have generated healthy discussions about new approaches to teaching and learning."*

These comments about changes in pedagogy being a direct threat to faculty identity was poignant, because it corresponded with my observations of certain faculty participants, and supported the change management literature that discusses change as being resisted because it threatens people's identities (Bovey & Hede, 2001; Ford & Ford, 2009). His comments on the nature of the university institution as being stagnant and poorly equipped for change was also supported by the researcher's observations as well as the literature on university institutions (Davies & Peterson, 2005; Strydom, et al., 2004). He also provided helpful personal observations of engineering culture, which validated the literature on the limitations of traditional engineering pedagogy and discourses criticized by Cech (2014), Goldberg, Somerville, and Whitney (2014), and Riley (2008) as well as some of the struggles to diversity and inclusion within engineering. Therefore, the fact that Indigenous persons were even on his radar is a testament his progressive approach as an administrator, which was also exhibited by his similarly progressive opinions about gender in engineering education.

5.7. Mentors meet the Administrator:

The final set of data came from the meeting held between the mentors and Professor Jackson at the close of curricular peer mentoring intervention, about the Maple University

Engineering program. Professor Jackson was interested in hearing from the mentors about their experience in the program, and they in turn were keen to speak to him. I worked with the mentors prior to the meeting to help them set an agenda of what they wanted to discuss with Professor Jackson, and some of their talking points. They approached the conversation nervously, but keen to communicate their ideas for improving the engineering program, and highlighting some of the failings of the program they experienced. The meeting was wide-ranging, but focused predominantly on the first-year engineering experience, the overall engineering experience, and the capstone course that senior engineers undertook.

Professor Jackson was receptive to the comments offered by the senior engineering undergraduate peer mentors about the first-year and overall engineering experience. The mentors spoke to him about ensuring the first-year experience helped first-year engineers realize the connection of first-year courses to senior disciplines; actively promoted student community and the development of an engineering family; and requiring students to attend institutional support programs. They also offered critiques of the overall program, saying it lacked meaningful courses and was overly focused on commercial/industrial content, did not prepare students to choose a discipline, explain to them the realities of the day-to-day work an engineer does, or assist them in developing entrepreneurial skills and abilities. They also felt there was a lack of awareness of concern about the heavy workload, preparation for managing that workload, and little emphasis on cultivating mental health despite the pressures of the program. Finally, the again spoke to the lack of engineering community, or as they said, an ‘engineering family’ in the program.

However, when it came to the senior undergraduate capstone course, the Professor Jackson was keen to justify why the course existed and operated the way it did. The mentors reported that this course is unpopular with senior engineers at Maple University, and this also came up in the discussion at the PAR Workshop that other senior students presented at, providing their perspective on the two non-technical courses taught by Karen King, both the senior course, and the junior course which precedes it. The mentors came prepared with well-thought out and evidenced criticisms about the course, and although Professor Jackson listened to them, but he was defended the program. This further supports the conclusion that change is difficult, and beholden to institutional power discourses and hierarchies. Despite their high status as students, and the reasoned arguments they presented about the senior capstone course, and their immediate knowledge of the course, they were unable to persuade Professor Jackson to see the reality of the course as they experienced it, and he seemed frustrated with their inability to hold the same opinion and perspective of the course he did. This exchange further demonstrates the high stakes of institutional change. Not only does it involve risk, not only is it difficult, but it can also challenge people to reconsider their personal values and beliefs.

5.8. Chapter Summary

The data collected in Phase II: Assessment, offers a comprehensive analysis of the curricular peer mentoring intervention. The data collected form the mentors shows that individual change process that they experienced, and shows the efficacy of the seminar course assignments and activities such as the PAR workshop modeled after a PAR process in facilitating that personal change. The interview data confirms the personal change they went through, but also spoke to the barriers to institutional change the program was up against with some host instructors and students in the host courses uninterested in engaging with the program. Furthermore, the mentor data also shows that not all of the mentors were engaged, despite serious efforts to engage them via the seminar course readings, assignments, and assessments. It supported conclusions about certain personality traits being necessary for a successful mentor, particularly conscientiousness and raised questions about whether being extraverted helped or hindered mentoring activities. The mentor data also showed the effect that the host instructors have on the level of mentor engagement, as even where the mentor was engaged, if the host instructor was not the mentoring program largely failed. Finally, the mentor data also underscored the difficulties of introducing change into an institutional culture that is strongly oriented towards established routines and is risk-averse.

The data collected from the student mentees added to this analysis of the intervention as not achieving its larger institutional change goals, by showing the issues students had connecting to the program, such as feeling there was a lack of communication about, and commitment to, the program by certain mentors and host instructors. The student survey data also shows the resistance to change among the student population in general, with many student respondents indicating they did not see a need for help, and were largely ignorant of the demands of the engineering program and disengaged with their own education. The host instructor data partially explained this too, showing how the uncertainty that the host instructors had about how to successfully utilize the program was a barrier to its success, as was the varied commitment that they themselves, and their assigned mentors, brought to the mentoring practice.

The host instructor data also suggests that perhaps academics that have lengthier tenures are more inclined to be unmotivated by, or dismissive of, change initiatives that have direct bearing on their professional practice. Academics with shorter tenures (i.e. new professors) or more precarious employment (i.e. contractual staff) may have to have more enthusiasm for change initiatives, seeing them as a possible aid to their professional development, or a further source of support. Finally, the host instructor data also demonstrates the different attitudes towards change people adopt: either they embrace the difficulty and the risk because they can see the potential opportunities change can bring, or they disengage or actively resist change because it is too difficult, risky, or upsets their personal comfort and established routines.

Both the mentor, mentee, and host instructor data emphasized the need to place the curricular peer mentors in courses where they would (a) enjoy mentoring most, (b) would connect best to students, and (c) be best suited to the course material. Furthermore, the data collected from the key administrator provided a bird’s eye view of the program, and placed that within a broad understanding of the engineering program at Maple University, as well as engineering education in general. Finally, it was the meeting of the mentors with the key administrator that best summarized the nature of university institutional environments, and the challenges to creating change in organizations like universities.

CHAPTER 6: Conclusion

6.1. Introduction

The thesis sought to answer whether curricular peer mentoring could be utilized as a critical pedagogical intervention to change university teaching and learning practices, meet the needs of diverse students, and minimize the costs of student academic support. It also asked whether curricular peer mentoring could act as a catalyst for change within a specific university faculty by analyzing the reactions from faculty stakeholders.

It categorized the data the collected in response to these questions through three themes: pedagogy, change, and agency. Pedagogy referred to university teaching and learning theories and practices, change referred to the individual and institutional responses to a shifting internal and external university environment, and agency referred to the capacity individuals and institutions have when acting in response to changes taking place within and around universities.

6.2. Data Phase I: Intervention

The first data set documented the process of establishing a new pedagogical approach in an engineering undergraduate program. Looking at the first phase data through the three themes shows the importance of agency. For example, my agency as the program initiator was curtailed by my relatively low status within the university hierarchy. Although Anderson (2011) argues that the way to create change within a university is through a participatory process led by change champions operating at various levels of the hierarchy, I first needed to convince someone with greater institutional authority to help me implement the program. This required me locating a high-status change champion, Professor Jackson. Although he had the greatest administrative agency among the actors within this study, and as such, could select host instructors and request their compliance in adopting the curricular peer mentoring program in their host courses, his agency was also curtailed because he could not demand they participate meaningfully in the program.

This data supports and subverts the literature on academic hierarchies and change management. On one hand, the power of administrators has increased substantially in the postmodern, neoliberal, university (Harpham, 2011). However, institutional features still exist, mainly tenure and unions, which allow individual *tenured* professors to resist or ignore administrative demands – to an extent. Furthermore, although change efforts that are collaborative and inclusive are more likely to succeed (Katz, 2013), this study showed without the support of a recognized authority figure it is difficult for a would-be change champion to lead a change effort.

However, change management literature argues that resistance is not necessarily damaging to a change process, and should be considered valuable feedback (Bovey & Hede, 2001; Ford & Ford, 2009). The focus should be on developing a leadership approach that can overcome resistance to change, by incentivizing others instead of threatening their sense of control and autonomy. The data from this study supports that hypothesis, as the resistance shown by some of the host instructors to the curricular peer mentoring program was arguably due to their sense of control and autonomy being threatened because they could not self-select to participate in the peer mentoring program, which curtailed their personal agency. The mentors freely chose to participate in the program. Consequently, there was a noticeable difference in the perception of the program and engagement with it, when comparing the mentors who chose to be there with the host instructors would were told to be there.

Agency was also relevant in terms of the peer mentors. Each mentor had to exercise their agency as a high-performing senior undergraduate engineer to collaborate with their host instructors and to solicit participation from the first-year engineering mentees in the host course. However, each peer mentor had a different perception of their agency, which impacted their capacity to act. For example, Katy had a strong sense of personal efficacy, and was confident in approaching the host instructor and communicating with the students in the host course. Claire did not have the same perception of her own agency, which was further impacted by the lack of relationship between her and her host instructor and the students in the host course.

Comparing the experience Katy had to the one Claire had is useful, because it both contradicts and supports the research about women in engineering as undervalued and disenfranchised (Faulkner, 2000; Faulkner, 2015; Frehill, 2004). On one hand, you have Katy, who is outgoing and outspoken, but also paired with a young male instructor, new to university teaching. Her experience is largely positive, she is respected and valued by her host instructor and given opportunities to lead elements of the course/curriculum. On the other hand, there is Claire, who is quiet and observant, but also paired with an older male instructor, with a lengthy academic tenure. Her experience is resoundingly different. It is difficult to definitively state whether it is an exclusionary engineering culture or individual personality that accounts for Claire’s negative experience. Even if Claire had been paired with Instructor 3, she would have still needed to learn to how to better assert herself to lead mentoring activities for her peers and engage in collegial dialogue with her host instructor.

Building upon, and increasing, the agency of the peer mentors was therefore an important pedagogical component of the weekly seminar. Establishing their perception of themselves through the personality tests formed a picture of their sense of agency upon entering the curricular peer mentoring program, and the seminar readings and assignments were set up to improve their sense of agency (or ‘leadership skills’ as it was referred to throughout the seminar activities). Leadership requires strong personal agency, even in entrenched hierarchies. Therefore, it was important that the mentors learn about agency/leadership as it applied to their immediate mentoring responsibilities in the host courses, where they were situated at the top of the ‘undergraduate hierarchy’ as seniors. However, the intention of the seminar course was to show them how they could translate their critical humanist learning and leadership skill set to new work environments where they might begin with lower status, but still use their increased sense of personal agency to effect positive change in institutional discourses. This was a key objective of the study – to promote critical thought within a scientific discourse concerned with practicalities – and inspired by Franklin (2000) and her critique of how scientists engage with the wider implications of their work.

This first data phase also provides information on the theme of pedagogy. The response of some of the host instructors shows how engineering education values logical, practical and analytical learning, and remains resistant to applying soft sciences research. Froyd, Wankat, & Smith (2012) argue that there has been a significant shift in engineering education towards embracing education, learning, and behavioural social sciences research, however, the results of this study suggest that critical, intepretivist approaches in engineering education are still underutilized and under-valued. Notably, the host instructors that were most resistant to the new student-centered, constructivist, critical pedagogical approach used in the curricular peer mentoring program were those who had been teaching longest. The instructors with the shortest teaching tenure, however, embraced the program. While not definitive, this suggests that changing pedagogy is more difficult for teachers who have a long-established pedagogical approach.

Although the mentors were initially hesitant about the program and its atypical pedagogical approach, they readily took to its intentions and content when the approach was explained and justified in relation to their learning outcomes. However, they sometimes struggled to apply a critical humanist thought process to the seminar readings and assignments without targeted support, which aligns with research into engineering students which shows mastering humanist criteria to be their area of weakness (Cech, 2014; Finelli, et al., 2012; Harding, Carpenter, & Finelli, 2012; Tang, 2014). The results of this study supports their conclusions, and also demonstrates that even when students are open to a new way of learning, to change their learning approach requires guidance. Therefore, the first phase of data also highlights the difficulty of change in institutional systems, and how certain educational approaches have deeply entrenched notions of who can have agency and what pedagogies are valid.

6.3. Data Phase II: Assessment

The second data phase was concerned with assessing the curricular peer mentor intervention through researcher observations, and surveying or interviewing various faculty actors, including the mentors, the host instructors, the mentees, the entire academic and non-academic staff within the faculty, and the administrator responsible for implementing the program. Looking at the data collected from each of these research populations indicates the theme of change was most prevalent during this phase of the study. The previous data phase required agency to implement and run the program, and pedagogy was key to understanding the program and how it was then situated in the established educational discourse in the faculty. Change took place because of the agency and pedagogy that characterized phase one. Therefore, that change would be the dominant theme during this phase was expected.

The mentors were central to the change that was introduced. Without them, no change could have occurred, as they *were* the change. They affected change simply by acting as a curricular peer mentor, which was not only a new position in the Maple University engineering faculty, but also theoretically juxtaposed to its established teaching and learning methods. They were also affected by change because they had to discover new ways of thinking and engaging with their discipline. Reviewing the documents that the mentors submitted, my observations of them, and the group interview I conducted with them at the end of the program, show the personal change the mentors went through during the program. They could reflect on their own strengths and weaknesses, and identify what actions they needed to take to progress as leaders. This in and of itself was a change to their learning practices – deliberately engaging in personal reflection – but it also caused them to make a change by acting on the result of that reflection. They also acted as agents of change, by performing their mentoring duties within and without the host courses. They introduced a shift in thinking to the host instructors about how they could teach, but also to the mentees about how they could learn. Although there was a mixed response to this from the host instructor and mentee populations, the change was still introduced by the mentors.

The mentees were intended to be the primary research population affected by the mentors, however, the survey responses showed how disengaged they were with the mentoring program. Other than a minority of comments submitted in response to open-ended survey questions, there was very little data to support that the majority of junior undergraduate students in the host courses were affected by the mentoring intervention – despite survey respondents recognizing a need for support in their learning and expressing a desire for change in the first-year engineering program. This disengagement possibly reflects the engrained nature of the positivist pedagogy still prevalent in engineering education, which emphasizes the teacher as the only knowledge holder (Freire, 1970) and rote learning as the preferred method of knowledge acquisition (Ballie & Catalano, 2009a). To be granted entry into the first-year engineering program at Maple University requires excellent high school grades in maths and sciences, which suggests entrants excel in traditional behaviourist, teacher-centered, rote-learning approaches to education (Cech, 2014; Riley, 2008). Furthermore, research shows that the types of students who are attracted to, and enter engineering education view knowledge as non-partisan, quantifiable, and testable, principles that underlie positivist pedagogy (Creach, 2011; Wierzbicka, 2011) and characterize more traditional engineering discourses (Faulkner, 2015; Tang, 2014). Results returned from the mentee research population confirm negative aspects of traditional engineering discourses are still strong at Maple University, and act as a barrier to change – even when a desire for change is felt among the junior students.

The host instructors were intended to be the auxiliary research population affected by the mentors, as they would have direct contact with the mentors, but on a lesser scale than the students (mentees) in their host courses. However, it was this research population that returned some of the richest qualitative data about change because some instructors refused to adopt the program in any meaningful capacity. While this may be due to other reasons such as workload and time constraints, the data suggests that entrenched engineering discourses are present and play a factor. Research conducted by others confirms this suggestion (Cech, 2014; Goldberg, Somerville, & Whitney, 2014; Riley, 2008). This becomes a self-perpetuating feedback loop, as the faculty reinforce this limiting engineering discourse, which is aligned with the image of a white, Western, English-speaking, heterosexual male (Cech & Waidzunas, 2011) that students are expected to assimilate and affirm. This serves to oust any non-conforming students, or shut down any pedagogical initiatives that do not take a behaviourist pedagogical approach (Cech, 2014; Riley, 2008). This is compounded by an academic hierarchy that allows some faculty to resist change, and is slow-moving even if a change is adopted (Brown, 2014; Strydom, et al., 2004). This preference and adherence to the banking system of education (Freire, 1970) and entrenched organizational structures, is something that Professor Jackson commented on as an ongoing cultural problem among the long-term and/or Non-Western and/or male professoriate, and an impediment to progressive teaching and learning methods, and diversifying the faculty academic staff.

The wider faculty and staff research population was tangential to the pilot program; however, the data collected from them supported the conclusions about the organizational culture in the engineering faculty as largely disengaged, which had emerged from the other research populations. There was minimal participation in the survey, and the few respondents that answered had little to no knowledge of the pilot curricular peer mentoring program – despite it and its activities being advertised on the closed-circuit televisions throughout the faculty, discussed at program and faculty level committee meetings, and hosted in four first-year engineering courses. This lack of engagement was not unique to the pilot program, as Professor Jackson noted this as a faculty-wide reality, with only a handful of academic and non-academic staff interested in working as a team; most were content to pursue their research objectives alone or with select individuals. This disconnected faculty culture among the academic and non-academic staff is a clear example of what Strydom, Zulu, & Murray (2004) call 'group inertia' which happens when specific group norms solidify resistance to change (p. 213).

Finally, it was the meeting with the senior administrator who acted as a change champion in piloting the curricular peer mentoring program that offered a high-level overview of change. He confirmed many of the researcher observations and qualitative data about the faculty's organizational culture as resistant to change. Strydom, Zulu, & Murray (2004) identify the following organizational barriers to change: structural inertia, limited focus on change, group inertia, and threats to expertise, power relations and established resource allocations (p. 213). These barriers were present in the engineering faculty at Maple University. First, the pilot program was up against structural inertia (mechanisms build into an institution that create stability), which was evidenced by the many, layered, bureaucratic processes required to simply offer the pilot program as a credited university course. Professor Jackson was aware of this, but because of his agency as a senior administrator – perhaps more importantly due to his unquestionable membership within the engineering discourse – he could navigate this barrier. Second, the program was up against the group inertia exhibited by the faculty members (including the host instructors). Third, the pilot program also acted as a threat to expertise, power relations and established resources within the faculty, which was evidenced by how resistant some of the long-term tenured professors were to the pilot program. Fourth, and perhaps most influential, was the limited focus on change among most the faculty. As Professor Jackson noted, many of the academic staff were used to pursuing a positivist banking system of education. They were accustomed to, and invested in maintaining a traditional engineering discourse. They reinforced it through their teaching.

Indeed, one of the most illuminating observations of this discourse I made as a researcher was when attending a lecture by a prominent, well-respected, highly-awarded, extensively published, engineering professor, Dr. Goldberg himself. He was arguing for a change in the traditional engineering discourse, by promoting a humanist, critically engaged, and ethically aware engineering pedagogy. His position, at the apex of the academic hierarchy, drew a sizeable crowd from across the faculty.[73] Despite his entire lecture being a direct argument against the conception of engineering as a male-dominated profession (among other characteristics of the engineering discourse Goldberg was criticizing), a male, middle-aged, visible minority, faculty member stood up and questioned how women could ever be as capable as men as maths. That the faculty member in question was a visible minority also spoke to the complexity of the sexist and racist ideologies at play among individuals and groups in the faculty.

In summary, the data collected from each research population provided different perspectives about change, but together they showed just how difficult it can be in an organizational culture with entrenched hierarchies and discourses that serve to maintain and safeguard the status quo. It also showed the necessity of change – that this was an organization that would benefit from changing its pedagogical approach to engineering education, and its view of who could have the agency to learn to be an engineer. This situation is not unique to the Faculty of Engineering at Maple University; it is a widespread problem across engineering programs in North America. The exclusionary nature of engineering is so problematic it has even been regularly reported about in mainstream news outlets[74]. This study adds to the growing academic literature – and

[73] The subject of his lecture, and his proposals for change in engineering pedagogy, were aligned with the theoretical principles and learning objectives of the curricular peer mentoring program. However, I would argue that if I had been giving the lecture, my low status with the academic hierarchy and position outside the engineering discourse would impact how the engineers present considered and responded to my message.

[74] "The case for change: why engineering needs more women" was reported in *The Guardian* in September 2013; "40% of female engineers are leaving the field. This might be why", was reported in *The Huffington Post* in August 2014; "The reasons so many women leave engineering has nothing to do with kids" was published in *Fortune* in August, 2016; "Why do so many women who study engineering leave the field?" was a leading article of *The Harvard Business Review* in August 2016.

public sentiment – about the need for engineering pedagogies and professions to change. It also details the difficulties to preventing that change.

6.4. Responding to the Research Questions

The thesis sought to answer the following research questions:

1) Could curricular peer mentoring be utilized as a critical pedagogical intervention to:

   i) change the Faculty of Engineering teaching and learning practices?

   ii) meet the needs of diverse students?

   iii) minimize the costs of student academic support?

2) Can curricular peer mentoring enact institutional change by addressing the needs and concerns of university education?

In response to the first question, this study found curricular peer mentoring had a mixed impact on university teaching and learning practices. The change introduced by the peer mentoring pilot program took place on a small scale, targeting first-year engineering courses. Of the selected host courses, meaningful change to teaching and learning practices only took place in ENGI B, which was taught by Instructor 3. He incorporated Katy into the regular teaching and learning activities of the course, and some of the students engaged with Katy. However, the idea of peer mentoring did have an overall impact on the teaching and learning practices of the engineering faculty, because the following academic year the faculty set-up its own version of the peer mentoring program.

It is difficult to assess whether the program met the needs of diverse students because there was such a small mentoring team, and a lack of engagement in the program from the students in the host courses. However, the program was set-up to respond to the exclusive culture of engineering, by educating the mentors about diversity and equity issues. In that sense, it had an impact on the three mentors, by helping them examine the social justice issues within engineering culture. Whether it met the needs of diverse students within the host courses is less easy to determine – not least because there was a significant lack of diversity within the faculty to begin with. A significant majority of the undergraduate engineers at Maple University were Canadian, with just over 11% registered as international students, which is well below the 19% international student enrolment average across Canadian engineering programs (Engineers Canada, 2015). The majority were also male, with just over a quarter of female undergraduate students (Engineers Canada, 2015). Therefore, assessing the effect of the program on meeting diverse student needs is challenging, because there was a lack of diversity among the student body. Furthermore, none of the comments made by survey respondents indicated they had sought out the curricular peer mentors for support about diversity issues or concerns, or because the mentors represented a gender/ethnicity/sexual-orientation with which they identified.

Answering the question of whether curricular peer mentoring could minimize the costs of student academic support is again difficult to assess because it would have required more data than was within the scope of this study to collect. Answering this question would require teasing out the costs of in-faculty academic support programs, but also the wider academic support services students can access from various student centres, such as study skill clinics, writing centres and workshops, library programs, academic advising, and offerings from student clubs and societies. Once those costs were determined, it would also require further surveying of the undergraduate students to evaluate how many students accessed support, and what support they accessed.

What can be said, however, is that the cost of running the curricular peer mentoring program was very low, with the only expenditure $5000 for the instructor salary. This cost could be eliminated if the program was run by a full-time faculty member. Therefore, it is probable that curricular peer mentoring could minimize the costs of student academic support if implemented and run as an alternative to the current in-house faculty support programs in the engineering program. At the very least, it would not increase the costs of providing academic support if it was folded into the teaching responsibilities of a fulltime faculty member.

The second research question asked whether curricular peer mentoring could act as a catalyst for change within a specific university faculty by analyzing the reactions from faculty stakeholders. This study showed that it could in part, while offering perspectives on how change was interpreted across diverse research populations. There was a wide-ranging response among persons directly and indirectly involved with the pilot program, with some people supporting the change, some resisting it, some ignorant of it, others passively accepting of it. For example, the program brought about a moderate change in how the mentors, senior administrator, one of the host instructors, and some of the students in the host courses, conceived of engineering education, or how they orchestrated or participated in engineering teaching and learning activities. For others, the change did not impact their teaching practice because it was either unwelcome, or unimplemented. That said, the pilot program still caused them to consider and respond to the change it was attempting to make in the first-year engineering courses. In that sense, even though they resisted or disregarded the program, it still affected a small change because it started a discussion about engineering pedagogy. Therefore, the program was an attempted change process, that for various reasons did not achieve the hoped for results.

Perhaps the most obvious example of how curricular peer mentoring acted as a catalyst for change within the faculty happened the following academic year, when the faculty adopted its own mentoring program. This shows that change is an ongoing process, and that introducing something new and different within a narrow discourse takes time before it is accepted and adopted into the discourse. It also shows how change that is instigated from someone external from the discourse may not be as readily accepted as change that is promoted from someone within the discourse. Furthermore, the change the program introduced did not end because the pilot program ended indicates that the data would have been very different, with more awareness and buy-in, if they program had run for another year.

6.5. Significance of this Research

The overall significance of this research is that is shows pedagogy is fundamental to change, because education shapes how people think and if you can change how they think you can change how they act and the systems they create. There are also five key contributions of this study: (i) the ***documentation of a change attempt***; (ii) offering a

critical engineering pedagogy; (iii) positioning ***curricular peer mentoring as a critical practice***; (iv) using ***critical pedagogy as a mechanism for discursive change***; (v) introducing ***change in neoliberal institutions***.

i. This research documents a change attempt from inception to conclusion within a university academic program. Universities are beset with questions about how to educate students effectively within a neoliberal discourse that values highly capable and useful professionals (Brown, 2011; Carlson, 2011), but devalues funding their education (Davies, et al., 2006,). Being able to offer a solution that may respond to this problem is useful. This research proposes a solution (curricular peer mentoring) and then examines its implementation and delivery to assess best practices for other institutions that might be interested in utilizing curricular peer mentoring in their own undergraduate education programs.

ii. This research offers a critical engineering pedagogy, one that can help realize the stated goals of engineering accreditation boards (ABET, 2016; ECAB, 2015; ENAEE, 2016), is aligned with the movement to create a critical, reflective, socially and ethically conscious engineering practice, and help combat traditional engineering discourses that continue to make engineering an exclusionary space (Ekoniak, 2013; Frehill, 2004; Mayes, 2014). This study offers suggestions about how engineering can be more student-centered, and use a constructivist approach to teaching and learning. Engineering accreditation boards are demanding engineering education adopt a social-sciences based, humanist curriculum, so future engineers understand social justice, and can reason ethically about their work (Tang, 2014). However, just making that demand on engineering education programs does not mean they are suddenly able to deliver a critical, humanist learning experience. Indeed, the shift to applying education and social behavioural sciences research has been focused on building constructivist teaching practices and learning assessment, not on expanding engineering curriculum beyond its empirical roots (Froyd, et al., 2012). Therefore, this study offers a possible teaching and learning method that can link the empirical knowledges that engineering education excels at, to the impact those knowledges have on society and the environment – a key learning outcome set by the Engineers Canada Accreditation Board (ECAB, 2015, pp. 3-15). It does this by deliberately designing course readings and assessments that prompt engineering undergraduates to recognize the role and responsibilities engineers have to protect public interest, asks them to analyze the impacts of engineering, and helps them develop an ethical awareness about their work.

iii. This research positions curricular peer mentoring as a critical practice. It is counter-hegemonic because it disrupts traditional pedagogical hierarchies: the teacher does not have sole ownership of the teaching practice, nor are they an unquestionable authority figure. The curricular peer mentors can also ‘teach’ by offering study session to their peers, or teaching a section of the course content, or providing one-on-one feedback to students. They can also model questioning and discussing with the teacher, so the teacher is reconceived as a facilitator of student learning not an infallible authority figure. Although this only happened on a small scale in ENGI B with Instructor 3 and Katy, the argument made in the theoretical framework of this research is for an *explicitly* critical approach to curricular peer mentoring that knowingly operates to deconstruct teacher-centered, banking-system education methods.

iv. This research uses critical pedagogy as a mechanism for discursive change. Critical pedagogy can explicitly interrogate the social, political, and economic aims of organizational discourses, by creating learning content and activities that challenge learners to think beyond the classroom. For example, in this study the curricular peer mentors mentored their junior peers, and read *The World in 2050*, which allowed them to examine engineering pedagogy and the engineering profession in relation to its social, political, and economic effects on the world. Through their mentoring practice and discussions of the course text, they could critically evaluate the teaching and learning practices in engineering, and how this can create an engineering culture that is disengaged with the wider social effects of engineering activity. As the mentor data showed, engaging in this critical practice increased their awareness of engineering discourses they disagreed with, and empowered them to make changes (i.e. Hosting the PAR workshop and providing counter-messages from the faculty and staff about aspects of the engineering program; speaking to Professor Jackson about the issues they had identified in the engineering program).

v. This research also showed how change can be introduced within a neoliberal institutional environment. First, it positioned the proposed change (in this study, curricular peer mentoring) as a cost-effective method to support students academically. By presenting and rationalizing the curricular peer mentoring program according to neoliberalist ideas of efficiency and cost, it was possible for me to gain an audience among high-level senior administrators across Maple University, and to eventually find a faculty that was willing to run the pilot program. Second, it encouraged participation in the change effort by appealing to neoliberal ideas. My aims in delivering the curricular peer mentoring program were critical, however, I could not alienate potential peer mentors from applying to the course. Therefore, I ensured the rhetoric used in recruiting mentors reflected neoliberal concepts such as ‘leadership’ ‘skills’ and ‘career-building’. Third, the proposed change did not poach limited resources from other institutional stakeholders. Instead, it provided further resources – the peer mentors – that could be used by faculty and/or administrators as another source of academic support. In fact, by not paying the peer mentors, but instead offering them course credit, the university financially benefitted from the mentoring program as the mentors paid tuition feeds to enrol in the pilot program and seminar course, while offered their mentoring services at no cost.

6.6 Recommendations

The following are general recommendations for implementing future iterations of the curricular peer mentoring program at Maple University, or for transferring it to other universities:

(1) Leader/Mentor Effectiveness:

a. Ensure leaders/mentors are consistently attending their host courses (once a week) and are provided time to check-in with the class during lecture hours
b. Require leaders/mentors to be in a particular space at a particular time on a regular basis.
c. Enable leaders/mentors to have an online forum presence in their host courses.
d. Require leaders/mentors to present on a relevant topic in their host course early in the term so students better know and remember their leader/mentor.
e. Continue to offer academic credit as an incentive to be a curricular peer mentor, so students are fully committed to the program.

(2) Host Instructor Effectiveness:

a. Ensure host instructors are well informed of the leadership/mentoring program intentions and are willing and able to support those intentions.
b. Ensure host instructors and their leaders/mentors meet-up prior to the term to plan the mentor involvement together, and continue with follow-up meetings throughout the term.
c. Follow up pre-term and ongoing meetings between instructors and mentors with a monthly check-in with the program coordinator.
d. Have host instructors incentivize students in the host course to access the program by consistently referring to the course, and allowing the mentor(s)

to take on visible responsibilities within the class and labs. Suggested actions include:

- Refer to peer leaders/mentors regularly in-class.
- Provide access to online course shell for leaders/mentors.
- Provide time/space for leaders/mentors to assist/give a course lecture.
- Provide a small assessment bonus for students who access leaders/mentors (course weighting and requirements to qualify as set by instructor).

(3) Program Effectiveness:

a. Identify a change champion with a high status within the organizational hierarchy to implement the curricular peer mentoring program.
b. Adopt the discursive language of the academic discourse to present the curricular peer mentoring program and to attract support for the course among possible mentors and host instructors
c. Advertise the leadership course early to encourage a higher number of peer mentors to enroll in the program, so the workload of leaders/mentors can be distributed, and their classroom presence increased.
d. Have the change champion and/or the curricular peer mentoring program coordinator, host a monthly meet-up for all mentors and host instructors to facilitate communication and collaboration among members of the host course instructor-mentor teams
e. Provide program coordinator with access to online course shell and/or class list-serv for all courses with the ability to post news items with host instructor permission.
f. Have program coordinator visit host courses monthly to observe leader/mentor interactions with students and host instructor to collect information on program delivery and possible alterations.

g. Restructure the leader/mentor seminar course to place more emphasis and assessment criteria on in-class participation, as well as student outreach and assistance.
h. Provide more support and guidance for host instructors on the intentions of the program and effective program delivery methods.

Finally, I would highly recommend that the program be piloted over an extended period of time, running in each Fall and Winter academic semesters over two or more academic years to allow time for the program to become known across the faculty, and refined to suit emerging needs and requirements each iteration of the program presents.

6.7 Concluding Thoughts

Critical pedagogue, Henry Giroux, argues that a radical, critical pedagogy is not one that simply critiques education and the powerful hierarchies and discourses it creates; it seeks to change them (2004). The curricular peer mentoring pilot program that was the nucleus of this research study attempted to do exactly that. The underlying principle of curricular peer mentoring is the empowerment of students, who are typically disempowered in traditional schooling. The act of curricular peer mentoring is the *change* that Giroux advocates for – this study did not simply offer a theoretical discussion and critique of engineering education – it attempted to change it through an emancipatory pedagogy. Furthermore, this emancipatory function was layered, working across the engineering hierarchy and discourse at multiple points.

First, there was the introduction of the program itself, which introduced a critical change to the first-year engineering program at a macro level. Second, there was the content of the seminar course that the peer mentors attended, which worked at a micro level, demanded they interrogate the knowledges valued in engineering, as they are often seen in isolation from society (Franklin, 2000). This helped them develop a critical consciousness by examining the engineering discourse in relation to the societal and institutional structures that control the means of knowledge production (Apple, 2010).

A critical pedagogy empowers those disenfranchised by traditional education systems, providing them with personal agency through that change (Freire, 1992; Giroux, 2004). Such an approach is necessary for constructing new possibilities for universities, so they become more than agencies of social reproduction that produce students and knowledges that facilitate neoliberalist economic goals. Although increasing personal agency is another core principle of critical pedagogy (Freire, 1970; 1994), this study showed the challenge of fully realizing this within the neoliberal university, which oppresses most institutional actors (Brooks, Byford, & Sela, 2015). Students must appease faculty, so they can obtain a degree and ergo employment. Faculty must appease other faculty and senior administrators, so they can obtain tenure and promotion. They must also appease funding agencies, so they can obtain research funding. In turn, funding agencies must appease the government, which wants research to be market-driven. Senior administrators must appease students (who are seen as paying customers) and external stakeholders (governments, industry) intent on corporatizing university organizational structures, and their research and teaching activities. Essentially, because the university is highly commercialized, and knowledge is valued for its profitability (Harpham, 2011), most of its actors are beholden to neoliberalist goals, and their agency is diminished.

The curricular peer mentoring program attempted to address this problem by building the personal agency of the peer mentors, using neoliberal ‘rewards’ to incentivize their learning as this was a familiar motivator for them. That is why the course rhetoric referenced ‘leadership’ and ‘leadership skills’ to attract the mentors, but the actual content was partly concerned with reflecting on the problems neoliberal ideologies have on engineering education, the profession and its wider global impact. The mentors were able to recognize that their agency, although presently curtailed as undergraduate students in the university hierarchy, could be powerful once they were professional engineers. Therefore, they not only evaluated how engineers use their agency to shape the world, but also reflected on how they would apply their own agency within the profession. The mentors appreciated these reflective activities, commenting that this was not something they felt they had done in their undergraduate learning, and wished it had been. Indeed, one mentor indirectly recognized the penetrating influence of neoliberalism on engineering education, saying all the courses were geared towards the oil industry; even a course she had taken on sustainable engineering was about making oil production more efficient.

Giroux (2004) asks “How is it possible to develop a radical pedagogy that acknowledges the spaces, tensions, and possibilities for struggle within the day to day workings of schools?” This study has responded to that question by examining change and agency within undergraduate engineering education. It concludes that change is unwieldy, piecemeal, slow, and bound by established hierarchies and discourses. However, it is also collaborative, productive, and innovates institutional thought and systems. Change has contradictory outcomes because of the differing actors within a change process, and their differing responses to that change. Their relative agency within the university hierarchy influences whether change is accepted, resisted, or ignored.

REFERENCES

Abrami P. C., Bernard R. M., Borokhovski E., Waddington D. I., Wade C. A., & Persson T. (2015). Strategies for teaching students to think critically: A meta-analysis. *Review of Educational Research, 85,* 275-314.

ABET. (2016, April 25). *Criteria for accrediting engineering programs, 2016 – 2017.* Retrieved from The Accreditation Board for Engineering and Technology: http://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2016-2017/

Advisory Panel on Canada's International Education Strategy. (2012). *International education: A key driver of Canada's future prosperity (final report).* Ottawa, ON: Foreign Affairs and International Trade Canada.

Aikenhead, G. (2002). Cross-cultural science teaching: Rekindling traditions for aboriginal students. *Canadian Journal of Science, Mathematics and Technology Education*, *2*(3), 287-304.

Ainley, M.G. (2000). Feminist perspectives on science and technology. *Women's Studies Quarterly*, *28*(1/2), 207-212.

Alexander P. A. (2014). Thinking critically and analytically about critical-analytic thinking: An introduction. *Educational Psychology Review*, *26*, 469-476.

Allais, S. (2014). A critical perspective on large class teaching: The political economy of massification and the sociology of knowledge. *Higher Education*, *67*, 721-734.

Allen, R. (2006). The race problem in the critical pedagogy community. In C. Rossatto, R. Allen, & M. Pruyn (Eds.), *Reinventing critical pedagogy* (pp. 3-21). Toronto, ON: Rowman & Littlefield.

Amsler, S. (2007). *The politics of knowledge in Central Asia: Science between Marx and the market*. London, England: Routledge.

Anderson, A. (2011). *Engaging resistance.* Redwood City, CA: Standford University Press.

Anderson, M. (2013). An alternative description of personality: The big-five factor structure. In E. Kessler (Ed.), *Encyclopedia of Management Theory* (pp. 77-80). Thousand Oaks, CA: SAGE.

Anderson, T. (2015). Seeking internationalization: The state of Canadian higher education. *Canadian Journal of Higher Education*, *45*(4), 166-187.

Apple, M. (2010). Theory, research, and the critical scholar/activist. *Educational Researcher*, *39*(2), 152-162.

Arendale, D. (2004). Pathways of persistence: A review of postsecondary peer cooperative learning programs. In I. Duranczyk, J. Higbee, & D. Lundell (Eds.), *Best practices for access and retention in higher education* (pp. 27-40). Minneapolis, MN: Center for Research on Development Education and Urban Literacy.

Arnold, J. E. (2012). Conceptualising teacher education and research as 'critical praxis'. *Critical Studies in Education, 53*(3), 281-295.

Arum, R., & Roksa, J. (2011). *Academically adrift: Limited learning on college campuses.* Chicago, IL: University of Chicago Press.

Association, A. A. (2015). *Global Census*. Retrieved from RACE: http://www. understanding race.org/lived/global_census.html

AUCC. (2011). *Trends in higher education volume 1: Enrolment.* Retrieved from https://www.univcan.ca/wp-content/uploads/2015/11/trends-vol1-enrolment-june-2011.pdf

AUCC. (2014). *Canada's universities in the world: AUCC internationalization survey*. Retrieved from https://www.univcan.ca/wp-content/uploads/2015/07/ internationalization-survey-2014.pdf

Austin, K., Gorsuch, G., Lawson, W., & Newberry, B. (2011). Developing and designing online engineering ethics instruction for international graduate students. *Instructional Science, 39*, 975-997.

Babaci-Wilhite, Z. (Ed.). (2016). *Human rights in language and stem education.* Rotterdam, Netherlands: Sense Publishers.

Baker, M. (2012). Modernity/coloniality and eurocentric education: Towards a post-occidental self-understanding of the present. *Policy Futures in Education, 10*(1), 4-22.

Ballie, C., & Catalano, G. (Eds.). (2009a). *Engineering and society: Working towards social justice: Part I: Engineering and society.* San Rafael, CA: Morgan & Claypool.

Ballie, C., & Catalano, G. (Eds.). (2009b). *Engineering and society: Working towards social justice: Part III: Engineering windows on society.* San Rafael, CA: Morgan & Claypool.

Bannerot, R. (2009, October 18-21). *Graduation success as a function of Myers Briggs temperament indicators in mechanical engineering.* Paper presented at the IEEE Frontiers in Education 39th Annual Conference, Texas. San Antonio, TX: IEEE.

Barbour, K. (2016). Dark clouds on the horizon. *Cultural Studies ↔ Critical Methodologies*, 1-5.

Barr, J. (2002). Universites after postmodernism. *International Journal of Lifelong Education*, *21*(4), 321-333.

Barr, R., & Tagg, J. (1995). From teaching to learning: A new paradigm for undergraduate education. *Change*, *27*(6), 12-25.

Barry, G. (2016, April 14). *Government expects MUN to maintain tuition freeze.* Retrieved from CBC Newfoundland & Labrador: http://www.cbc.ca/news/canada/newfoundland-labrador/tuition-freeze-budget-mun-2016-newfoundland-1.3535785

Barton, A.C., & Osborne, M.D. (2000). Building inclusive science in classrooms through oral histories. *Women's Studies Quarterly, 28*(1/2), 236-250.

Bartsch, I. (2000). Women, gender, and science: The need for orbitals in higher education. *Women's Studies Quarterly, 28*(1/2), 264-270.

Basen, I. (2014, September 07). *Most university undergrads now taught by poorly paid part-timers: Universities increasing use of sessional, contract academic staff.* Retrieved from http://www.cbc.ca/news/ canada/ most-university-undergrads-now-taught-by-poorly-paid-part-timers-1.2756024

Bastalich, W., Franzway, S., Gill, J., Mills, J., & Sharp, R. (2007). Disrupting masculinities. *Australian Feminist Studies*, *22*(54), 385-400.

Baum, S., Ma, J., & Payea, K. (2010). *Education pays 2010: The benefits of higher education for individuals and society.* Retrieved from http://trends.collegeboard .org/downloads/

BBC. (2008, March). *Populous - BBC Poll.* Retrieved from http://news.bbc.co.uk/1/ shared /bsp/hi/pdfs/06_03_08_Newsnight_White%20Season_poll.pdf

BBC. (2009, January 2). *Blears concern for 'ignored poor'.* Retrieved from BBC News: http://news.bbc.co.uk/2/hi/uk_news/politics/7807446.stm

Benckert, S., & Staberg, E. (2000). Women in chemistry and physics: Question of similarity and difference. *Women's Studies Quarterly, 28*(1/2), 86-103.

Bennett, D. K. (2015). First year engineering students: Perceptions of engineers and engineering work amongst domestic and international students. *The International Journal of the First Year in Higher Education*, *6*(1), 89-105.

Bibeau, G. (2011). What is human in humans? Responses from biology, anthropology, and philosophy. *Journal of Medicine & Philosophy*, *36*(4), 354-363.

Biggs, J. (1996). Enhancing teacing through constructivist alignment. *Higher Education, 18*(1), 347-364.

Bilimoria, D., & Stewart, A. (2009). “Don’t ask, don’t tell”: The academic climate for lesbian, gay, bisexual, and transgender faculty. *NWSA Journal, 21*(2), 85-103.

Bix, A. (2004). From "engineeresses" to "girl engineers" to "good engineers": A history of women's u.s. engineering education. *NWSA Journal*, *16*(1), 27-49.

Blake, J. (2011, March 4). *Are whites racially oppressed?* Retrieved from CNN: http://www.cnn.com/2010/US/12/21/white.persecution/

Bloom, B. (1956). *Taxonomy of educational objectives: Handbook 1: Cognitive domain.* New York, NY: David McKay.

Bloomberg, L. D., & Volpe, M. (2008). *Completing your qualitative dissertation: A roadmap from beginning to end*. Los Angeles, CA: SAGE.

Boeije, H. (2002). A purposeful approach to the constant comparative method in the analysis of qualitative interviews. *Quality and Quantity, 36*(4), 391-409.

Boeren, E. (2015). Surveys as tools to measure qualitative and quantitative data. In Brewer, E.W., Torrisi-Steele, G., & Wang, V. C. X. (Eds.), *Handbook of research on scholarly publishing and research methods* (pp. 415-434). Hershey, PA: Information Science Reference

Bogdan, R. (1973). Participant observation. *Peabody Journal of Education (50)*4, 302-308.

Bogdan, R. & Biklin, S. (2007). *Qualitative research for education: An introduction to theory and methods*. New York, NY: Pearson.

Boland, H. (1995). Postmodernism and higher education. *The Journal of Higher Education, 66*(5), 521-559.

Bonilla-Silva, E., & Embrick, D. (2006). Racism without racists: “Killing me softly” with color blindness. In C. Rossatto, R. Allen, & M. Pruyn (Eds.), *Reinventing critical pedagogy* (pp. 21-35). Toronto, ON: Rowman & Littlefield.

Boone, M. (2016, April 18). *Memorial University tries to 'minimize impact' of budget cuts.* Retrieved from http://www.cbc.ca /news/canada/newfoundland-labrador/budget-cuts-memorial-university-consultations-1.3540655

Boron, A. A. (2006). Reforming the reforms: Transformation and crisis in Latin American and Caribbean universities. In Rhoads, R.A., & Torres, C.A. (Eds), *The university, state and market: The political economy of globalization in the Americas* (pp. 141-163). Stanford, CA: Stanford University Press.

Bourdieu, P. (December 1998) ‘The essence of neoliberalism’. *Le Monde Diplomatique*. Retrieved from http://mondediplo.com/1998/12/08bourdieu

Bovey, W., & Hede, A. (2001). Resistance to organizational change: The role of defense mechanisms. *Journal of Managerial Pyschology*, *16*(7/8), 534-549.

Bowen, G. A. (2009). Document analysis as a qualitative research method. *Qualitative Research Journal (9)*, 27-40.

BPS. (2016, June 25) *Psychological Terms*. Retrieved from British Psychological Society http://www.bps.org.uk/psychology-public/psychological-terms/ psychological-terms

Bradshaw, J. (2013, September 18). Specialize or risk losing funding, Ontario tells universities and colleges. *The Globe and Mail*. Retrieved from https://www. theglobeandmail.com/news/national/specialize-or-risk-funding-ontario-tells-universities-and-colleges/article14393294/

Bradshaw, J. (2013, March 7). Universities bearing the brunt of Alberta’s slash to education spending. Retrieved from http://www.theglobeandmail.com/news/ politics/universities-bearing-the-brunt-of-albertas-slash-to-education-spending/article9489506/

Brewer, E., Torrisi-Steele, G., & Wang, V. (2015). Survey research: Methods, issues, and the future. In E.W. Brewer, G. Torrisi-Steele, & V.C.X. Wang, (Eds.), *Handbook of research on scholarly publishing and research methods* (pp. 396-414). Hershey, PA: IGI Clobal.

Brock, T. (2010). Young adults and higher education: Barriers and breakthroughs to success. *The Future of Children, 20*(1), 109-132.

Broido, E., Brown, K., Stygles, K., & Bronkema, R. (2015). Responding to gendered dynamics: Experiences of women working over 25 years at one university. *The Journal of Higher Education, 86*(4), 595-627.

Brookfield, S. (1995). *Becoming a critically reflective teacher.* San Francisco, CA: Joessey-Bass.

Brookfield, S. (2003a). Putting the critical back into critical pedagogy: A commentary on the path of dissent. *Journal of Transformative Education*, *1*(2), 141-149.

Brookfield, S. (2003b). The praxis of transformative education. *Journal of Transformative Education, 1*(3), 212-226.

Brookfield, S. (2006). *The skillful teacher: On technique, trust, and responsiveness in the classroom.* San Francisco, CA: Jossey-Bass.

Brooks, R., Byford, K. and Sela, K. (2015). The changing role of students' unions within contemporary higher education, *Journal of Education Policy*, *30*(2), 165–181.

Brown, M. (2011). The sciences vs. the humanities: A power struggle. Retrieved from *The Chronicle of Higher Education* http://chronicle.com/blogs/old-new/the-sciences-vs-humanities-a-power-struggle/336

Brown, S. (2012). Managing change in universities: A sisyphean task? *Quality in Higher Education*, *18*(1), 139-146.

Brown, S. (2014). You can't always get what you want: Change management in higher education. *Campus-Wide Information Systems*, *31*(4), 208-216.

BU. (2015). *Peer assisted learning (PAL)*. Retrieved https://www1.bournemouth.ac.uk/discover/library/guests-visitor-information/peer-assisted-learning-pal

Buchbinder, H., & Newson, J. (1990). Corporate-university linkages in Canada: transforming a public institution. *Higher Education*, *20*, 355-379.

Bunda, T. (2012). Negotiating university 'equity' from Indigenous standpoints: a shaky bridge. *International Journal of Inclusive Education*, *16*(9), 941-957.

Byrnes, J.P. & Dunbar, K.N. (2014). The nature and development of critical-analytic thinking. *Educational Psychology Review*, *26*, 477-493.

Cabrera, N. (2014). Exposing whiteness in higher education: White male college students minimizing racism, claiming victimization, and recreating white supermacy. *Race Ethincity and Education, 17*(1), 30-55.

Cain, T. (2011). Teachers' classroom-based action research. *International Journal of Research and Method in Education, 34*(1) 3-16.

Caldwell, R. (2003). Models of change agency: A fourfold classification. *British Journal of Management, 14*(2), 131-142.

Cameron, E., & Green, M. (2012). *Making sense of change management.* London, England: Logan Page.

Cameron, K., & Quinn, R. (2006). *Diagnosing and changing organizational culture.* San Francisco, CA: Jossey-Bass.

Canaan, J. E. (2008). A funny thing happened on the way to the (European social) forum, or, how new forms of accountability are transforming academics: Identities and possible responses. In J. Canaan and W. Shumar (Eds.), *Structure and agency in the neo-liberal university* (pp. 256-277). New York, NY: Routledge.

Canaan, J. E., & Shumar, W. (Eds.). (2008). *Structure and agency in the neoliberal university*. New York, NY: Routledge.

Canadian Race Relations Foundation (CRRF). (2017). *Canadian Race Relations Foundation Glossary*. Retrieved from the CRRF: October 13, 2017: http://www.crrf-fcrr.ca/en/resources /glossary-a-terms-en-gb?limit= 50&order by=alpha & letter=r

Canadian SI. (2016). *SI In Canada*. Retrieved from Canadian SI. Retrieved from https://canadiansi. uoguelph.ca/si-in-canada

Cannella, G., & Koro-Ljungber, M. (2017). Neoliberalism in higher education: Can we understand? Can we resist and survive? Can we become without neoliberalism? *Cultural Studies ↔ Critical Methodologies, 17*(3), 155-162.

Carleton. (2016). *Aboriginal enriched support program.* Retrieved from http://carleton.ca/aesp/

Carlson, S., & Blumenstyk, G. (2012, December 17). *For whom is college being reinvented?* Retrieved from http://chronicle.com: http://chronicle.com/article/The-False-Promise-of-the/136305/

Carter, P. (2007). *IQ and Personality Tests: Assess and Improve your Creativity, Aptitude, and Intelligence*. London, England: Kogan Page.

Carter, L. G. (Ed.). (2013). *The change champion's field guide.* Somerset, England: Center for Creative Leadership.

Caruana, V. (2010). Global citizenship for all: Putting the 'higher' back into UK higher education? In N. Foskett & F. Maringe (Eds.), *Globalization and internationalization in higher education: Theoretical, strategic and management perspectives.* (pp. 51-64). New York, NY: Continuum.

Castellano, M. (2000). Updating aboriginal traditions of knowledge. In Hall, B., Dei, G., & Rosenberg, D. (Eds.), *Indigenous knowledges in global contexts: Multiple readings of our world* (pp. 21-37). Toronto, ON: University of Toronto Press.

Catalano, G. (2006). Engineering ethics: Peace, justice, and the earth. *Synthesis lectures on engineers, technology and society, 1*(1) 1-80.

Catalano, G. (Ed.). (2009). *Engineering and Society: Working towards social justice: Part II: Engineering decisions in the 21st century.* San Rafael, CA: Morgan & Claypool .

Caulley, D. N. (1983). Document analysis in program evaluation. *Evaluation and Program Planning, 6,* 1, 19-29.

CAUT. (2012a). *CAUT Almanac of post-secondary education in Canada.* Retrieved from https://www.caut.ca/docs/almanac/2012-2013-caut-almanac-of-post-secondary-education-in-canada.pdf?sfvrsn=0

CAUT. (2012b, October). Post-Secondary Education Faces Serious Attack in Ontario. Retrieved from https://bulletin-archives.caut.ca/bulletin/articles/2012/10/post-secondary-education-faces-serious-attack-in-ontario

CAUT. (2013). Federal Funding of Basic Research. *CAUT Education Review, 13*(1), 1-6.

CAUT. (2015a). *CAUT almanac of post-secondary education in canada.* Retrieved from: https://www.caut.ca/docs/default-source/almanac/almanac-2014-2015.pdf?sfvrsn=8

CAUT. (2015b). *Trends in university finances in the new millennium 2000/01-2012/13.* https://www.caut.ca/sites/default/files/caut-education-review-spring-2015.pdf

CAUT. (2015c, April 24). *Canada's profs raise alarm over Nova Scotia bill.* Retrieved from https://www.caut.ca/news/ 2015/04/24/canada-s-profs-raise-alarm-over-nova-scotia-bill

CBC News. (2015, May 13). *Any tuition fee increase at MUN won't happen until 2016* . Retrieved from http://www.cbc.ca/news/ canada/newfoundland-labrador/any-tuition-fee-increase-at-mun-won-t-happen-until-2016-1.3072130

CBIE. (2016a). *Our mission, vision, and values.* Retrieved from http://cbie-bcei.ca/who-we-are/our-mission-vision-and-values/

CBIE. (2016b). *Research reports.* Retrieved from http://cbie-bcei.ca/media-centre/publications/research-reports/

Cech, E. (2014). Culture of disengagement in engineering education? *Science, Technology, & Human Values, 39*(1), 42-72.

Cech, E., & Waidzunas, T. (2011). Navigating the heteronormativity of engineering: the experiences of lesbian, gay, and bisexual students. *Engineering Studies, 3*(1), 1-24.

Charbonneau, L. (2014, July 16). Sessional instructors: What we know so far. *University Affairs*. Retrieved from http://www.universityaffairs.ca/opinion/margin-notes/sessional-instructors-what-we-know-so-far/

Chickering, A., & Gamson, Z. (1987). Seven principles for good practice in undergraduate education. *American Association for Higher Education & Accreditation, 39*(7), 3-7.

Chiefs Assembly on Education. (2012). *A portrait of first nations and education.* Retrieved from http://www.afn.ca/uploads/files/events/fact_sheet-ccoe-3.pdf

Choise, S. (2015, April 29). Cash-strapped Nova Scotia universities could ban strikes with new bill. *Globe and Mail*. Retrieved from http://www.theglobeandmail.com

/news/national/education/cash-strapped-nova-scotia-universities-could-ban-strikes-with-new-bill/article24178513/

Chomsky, N. (1999). *Profit over people: Neoliberalism and global order.* New York, NY: Seven Stories Press.

Clark, I., Van Loon, R., & Trick, D. (2011). *Academic reform: Policy options for improving the quality and cost-effectiveness of undergraduate education in Ontario.* Kingston, ON: School of Policy Studies, Queen's University.

Clark, M.C., & Wilson, A.L. (1991). The theory of transformational learning. *Adult Education Quarterly, 41*(2), 75-9.

Colin, S., & Lund, C. L. (2010). White racist ideology and the myth of a postracial society. *New Directions for Adult and Continuing Education, 2010*(125), 7-13.

Corrigan, K. (2012). Collaborative thinking: The challenge of the modern university. *Arts & Humanities in Higher Education, 11*(3), 262-272.

Council of Canadian Academies. (2009). *Innovation and business strategy: Why canada falls short.* Retrieved from http://www.scienceadvice.ca/uploads/eng/assessments%20and%20publications%20and%20news%20releases/inno/(2009-06-11)%20innovation%20report.pdf

Coutrue, J. (2000). Native studies in the academy. In Hall, B., Dei, G., & Rosenberg, D. (Eds.), *Indigenous knowledges in global contexts: Multiple readings of our world* (pp. 157-168). Toronto, ON: University of Toronto Press.

Cox, M., & Diefes-Dux, H. (2006, October 27-31). *Development and assessment of an undergraduate curriculum for first-year international engineering students*. Paper presented at the IEEE Frontiers in Education 36th Annual Conference, California. San Diego, CA: IEEE.

Cranton, P. (2011). A transformative perspective on the scholarship of teaching and learning. *Higher Education Research & Development*, *30*(1), 75-86.

Cranton, P. (2015). Teachers as researchers: Participatory and action research. In E.W. Brewer, G. Torrisi-Steele, & V.C.X. Wang, (Eds.), *Handbook of research on scholarly publishing and research methods* (pp. 312-328). Hershey, PA: IGI Clobal.

Creach, R. (2011). *Logical emprицism.* Retrieved from The Standford Encyclopedia of Philosophy: http://plato.stanford.edu/archives/win2011/entries /logical-empiricism

Creswell, J. W. (2015). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (5th ed.). Saddle River, NJ: Pearson.

Cuseo, J. (2007). The empirical case against large class size: Adverse effects on the teaching, learning, and retention of first-year students. *Journal of Faculty Development*, *21*, 5-21.

Dass, N. (2008). Recouping the Value of the Humanities. *College Quarterly, 11*(4), 2.

Davenport, P. (2001). Universities and the knowledge economy. *Ivey Business Journal, 65*(5), 64-69.

Davidson, C. (2011). Strangers on a Train. *Academe, 97*(5), 12-18.

Davies, B., & Peterson, E. (2005). Neo-liberal discourse in the academy: The forestalling of (collective) resistance. *Learning and Teaching in the Social Sciences*, *2*(2), 77-98.

Davies, B., Gottsche, M., & Bansel, P. (2006). The rise and fall of the neo-liberal university. *European Journal of Education, 41*(2), 305-319.

Day, H. (2007). Employability through the humanities: The sinister figure in the wings? *International Journal of the Humanities, 5*(8), 61-68.

De Leo, J. (2017). *Higher Education under late capitalism: Identity, conduct, and the neoliberal condition.* Cham, Switzerland: Springer International Publishing.

Dei, G. (2000). African development: The relevance and implications of 'Indigenousness. In B, Hall, G. Dei, & D. Rosenberg, (Eds.), *Indigenous knowledges in global contexts: Multiple readings of our world* (pp. 70-89). Toronto, ON: University of Toronto Press.

Delanty, G. (2002). The governance of universities: What is the role of the university in the knowledge society? *Canadian Journal of Sociology, 27*(2), 185-198.

Department of Canadian Heritage. (2005). *A Canada for all: Canada's action plan against racism.* Retrieved from http://publications.gc.ca/collections/Collection /CH34-7-2005E.pdf

Denzin, N. K. (1989). *The research act: A theoretical introduction to sociological methods*. Englewood Cliffs, N.J: Prentice Hall.

Derrida, J. (1976). *Of Grammatology* (G.C. Spivak, Trans.). Baltimore, MD: Johns Hopkins University Press.

Doolittle, P. (2003). Constructivism as a theoretical foundation for the use of technology in social studies. *Theory and Research in Social Education, 31*(1), 72-104.

Driedger, L., & Reid, A. (2000). Public opinion on visible minorities. In L. Driedger, & S. Halli, (Eds.), *Race & racism: Canada's challenge* (pp. 152-172). Montreal, QC, Canada: McGill-Queen's University Press.

Duff, A., Rogers, D., & Harris, M. (2006). International engineering students: avoiding plagarisim through understanding the western academic context of scholarship. *European Journal of Engineering Education, 31*(6), 673-681.

Dutta, D. (2016). Negotiations of cultural identities by Indian women engineering students in US engineering programs. *Journal of Intercultural Communication Research, 45*(3), 177-195.

ECAB. (2015). *Engineers Canada accreditation board: 2015 accreditation criteria and procedures.* Retrieved from https://engineerscanada.ca/accreditation/accreditation-resources

Ecker, J., Rae, J., & Amandeep, B. (2015). Showing your pride: A national survey of queer student centres in Canadian colleges and universities. *Higher Education: The International Journal of Higher Education Research, 70*(5), 881-898.

Editor. (2002). Science's racist shame. *New Scientist, 173*(2333), 44.

Eddy, S. L., Brownell, S. E., & Wenderoth, M. P. (2014). Gender gaps in achievement and participation in multiple introductory biology classrooms. *CBE Life Sciences Education, 13*(3), 478-92.

Edmead, C. (2013). Increasing international and domestic student interaction through group work: A case study form the humanities. In J. Ryan (Ed.), *Cross-cultural teaching and learning for home and international students: Internationalisation of pedagogy and curriculum in higher education* (pp. 15-26). Oxon, England: Routeledge.

Edwards, R., & Usher, R. (2001). Lifelong learning: A postmodern condition of education. *Adult Education Quarterly, 51*, 273-287.

Ehrenberg, R. G. (2001). Class size and student achievement. *Psychological Science in the Public Interest, 2*(1), 1-30.

Eisenkraft, H. (2010). Racism in the Academy. *University Affairs, 51*(9), 12-19.

Ekoniak, M. (2013, October 23-26). *Engineering culture and LGBTQ engineers' use of social change strategies*. Paper presented at the IEEE Frontiers in Education 43rd Annual Conference, Oklahoma. Oklahoma City, OK: IEEE.

Employment & Social Development Canada. (2009). *Poverty Profile Special Edition: Snapshot of Racialized Poverty in Canada*. Ottawa, ON: National Council of Welfare.

ENAEE. (2016, April 25). *Standards and guidelines for accreditation of engineering programmes.* Retrieved fromhttp://www.enaee.eu/eur-ace-system/eur-aceframework-standards/standards-and-guidelines-for-accreditation-of-engineering-programmes/

Engineering Council. (2016, April 25). *Accreditation of higher education programmes.* Retrieved from http://www.engc.org.uk/standards-guidance/standards/ accreditation-of-higher-education-programmes-ahep/

Engineers Canada. (2014). *Canadian engineers for tomorrow: Trends in engineering enrolment and degrees awarded 2010-2014.* Retrieved from https://engineers canada .ca/sites/default/files/EnrolmentReport2014-e-r2.pdf

Engineers Canada. (2015). *2015 Resources Survey.* Ottawa, ON: Engineers Canada.

Engineers Canada. (2016a). *Engineers Canada Accreditation Board.* Retrieved from Engineers Canada: https://www.engineerscanada.ca/engineers-canada-accreditation-board

Engineers Canada. (2016b). *Engineers Canada's Board.* Retrieved from Engineers Canada: https://www.engineerscanada.ca/engineers-canadas-board

Engineers Without Borders Canada (n.d.) *Chapters*. Retrieved from https://www.ewb.ca/en/chapters

Enns, L. (2014, 03 13). Post-secondary education council to be eliminated. *Winnipeg Free Press*. Retrieved from http://www.winnipegfreepress.com/local/Post-secondary-education-council-to-be-eliminated-250233601.html

Erwin, A., & Wood, M. (2014). *The one percent at state U: How public university presidents profit form rising student debt and low-wage faculty labor.* Washington, DC: Institute for Policy Studies.

Evers, J.C. & Loes van Staa, A. (2010). Qualitative analysis in case study. In G. Durepos, A.J. Mills, & E. Wiebe, (Eds.), *Encyclopedia of case study research (Vo1. 2*, pp. 749-757). Los Angeles, CA: SAGE.

Exeter, D., Ameratunga, S., Ratima, M., Mortona, S., Dickson, M., & Hsu, D. (2010). Student engagement in very large classes: The teachers' perspective. *Studies in Higher Education, 35*(7), 761-775.

Facione, P.A. (1990). *Critical thinking: A statement of expert consensus for purposes of education assessment and instruction. Research findings and recommendations.* Newark, DE: American Philosophical Association.

Faulkner, W. (2000). Dualism, hierarchies and gender in engineering. *Social Studies of Science, 30*(5), 759-792.

Faulkner, W. (2015). 'Nuts and bolts and people' gender troubled engineering identities. In S. Christensen, C. Didier, A. Jamison, M.Meganck, C. Mitcham, & B. Newberry, (Eds.), *Engineering identities, epistemologies and values: Engineering education and practice in context*, (Vol. 2, pp. 23-41). Cham, Switzerland: Springer International Publishing.

Field, C., Jones, G., Karram Stephenson, G., & Khoyetsyan, A. (2014). *The "other" university teachers: Non-full-time instructors at Ontario universities.* Toronto, ON: Higher Education Quality Council of Ontario.

Findlay, S. (2011, January 11). Whatever happened to tenure? The backbone of today's university is the ill-paid, overworked lecturer. *Macleans*. Retrieved from http://www.macleans.ca/education/uniandcollege/whatever-happened-to-tenure-2/

Finelli, C., Holsapple, M., Ra, E., Bielby, R., Burt, B., Carpenter, D., . . . Sutkus, J. (2012). An assessment of engineering students' curricular and co-curricular experiences and their ethical development. *Journal of Engineering Education, 101*(3), 469-494.

Fins, J. (2010). C.P. Snow's "Two Cultures" fifty years later: An enduring problem with an elusive solution. *Technology in Science, 32*, 1-4.

First Nations & Indigenous Studies (2009). *Terminology*. Retrieved from http://indigenousfoundations.arts.ubc.ca/terminology/#indigenous

Fisher, K. (2013, May 9). *Amid security worries, student visas come under new scrutiny.* Retrieved from http://chronicle.com/article/Amid-Security-Worries-Student/139149/

Flick, U. (2007). *Managing quality in qualitative research*. Los Angeles CA: SAGE.

Ford, J., & Ford, L. (2009). Decoding Resistance to Change. *Harvard Business Review, 87*(4), 99-103.

Foreign Affairs, Trade, and Development Canada. (2014). *canada's internationalization strategy: Harnessing our knowledge advantage to drive innovation and prosperity.* Ottawa, ON: Author.

Foskett, N. (2010). Global markets, national challenges, local strategies: The strategic challenge of internationalization. In N. Foskett, (Ed.), *Globalization and internationalization in higher education: theoretical, strategic and management perspectives.* (pp. 35-51). New York, NY: Continuum.

Fosnot, C. (Ed.). (2005). *Constructivism: theory, perspectives, and practice.* New York, NY: Teachers College Press.

Foucault, M. (1982). The Subject and power. *Critical Inquiry, 8*(4), 777-795.

Fox, M. (2000). Organizational environments and doctoral degrees awarded to women in science and engineering departments. *Women's Studies Quarterly, 28*(1/2), 47-61.

Fram, S. (2013). The constant comparative method of analysis outside of grounded theory. *The Qualitative Report, 18*(1), 1-25.

Franklin, U. (2000). What is at Stake? Universities in Context. In J. Turk, (Ed.), *The corporate campus: Commercalization and the dangers to canada's colleges and University* (pp. 17-23). Toronto, ON: James Lorimer & Company Limited.

Fredrickson, C. (2015, September 15). There is no excuse for how universities treat adjuncts. *The Atlantic*. Retrieved from http://www.theatlantic.com/business/ archive /2015/09/higher-education-college-adjunct-professor-salary/404461/

Freebody, P. (2003). *Qualitative research in education: Interaction and practice*. Thousand Oaks, CA: SAGE.

Frehill, L. (2004). The gendered construction of the engineering profession in the united states, 1893-1920. *Men and Masculinities, 6*(4), 383-403.

Freire, P. (1970). *Pedagogy of the oppressed.* New York, NY: Seabury Press.

Freire, P. (1994). *Pedagogy of hope: Reliving pedagogy of the oppressed.* New York, NY: Continuum.

Freire, P. (1997). A Response. In P. Freire, P., & J.W. Fraser, J.W. (Eds.), *Mentoring the mentor: A critical dialogue with Paulo Freire* (pp. 303-331). New York, NY: Peter Lang.

Freire, P., Fraser, J.W. (Eds.). (1997). *Mentoring the mentor: A critical dialogue with Paulo Freire.* New York, NY: Peter Lang.

Friesen, J., & Krauth, B. (2012). *Key policy issues in aboriginal education: An evidence-based approach.* Toronto, ON: Council of Ministers of Education.

Froyd, J., Wankat, P., & Smith, K. (2012). Five major shifts in 100 years of engineering education. *Proceedings of the IEEE, 100*, 1344-1360.

Gafney, L., & Varma-Nelson, P. (2008). Peer-led team learning: Evaluation, dissemenation, and institutionalization of a college level initiative. In K. Cohen, (Ed.), *Innovations in science education and technology* (Vol. 16). New York, NY: Springer .

Gallegos, B. (2005). Whose Lady of Guadalupe? Indigenous performances, latina/o identities, and the postcolonial project. In G. Fischman, (Ed.), *Critical theories, radical pedagogies, and global conflicts* (pp. 249-263). Toronto, ON: Rowman & Littlefield.

Garland, R. (2012). The humanities: plain and simple. *Arts & Humanities In Higher Education, 11*(3), 300-312.

Garrison, D., & Arbaugh, J. (2007). Researching the Community of Inquiry framework: Review, issues, and future directions. *The Internet and Higher Education, 10*(2007), 157-172.

Geisinger, K. (2013). Reliability. In K. Geisinger, B.A.Bracken, J. Carlson, J.C. Hanser, N.R. Kuncel, S.P. Reise, & M. Rodriguez, (Eds.), *APA handbook of testing and assessment in psychology* (Vol. 1, pp. 21-42). Washington, DC: American Psychological Association.

Geller, E. (2002). Leadership to overcome resistance to change: It takes more than consequence control. *Journal of Organizational Behavior Management, 22*(3), 29-49.

Gibbons, A. (2015, April 2). How Europeans evolved white skin. *Science*. Retrieved from http://www.sciencemag.org/news/2015/04/how-europeans-evolved-white-skin

Gibbs, P. (2010). The commodification and standardization of higher education. In N. Foskett, & F. Maringe, (Eds.), *Globalization and internationalization in higher education: Theoretical, strategic and management perspectives* (pp. 241-255). New York, NY: Continuum.

Gillis, C. (2016, April 14). A budget to drive Newfoundlanders away. *Maclean's*. Retrieved from http://www.macleans.ca/news/canada/a-budget-to-drive-newfoundlanders-away/

Ginoria, A., Marshall, T., & Breckenridge, L. (2000). The feminist and the scientist: One and the same. *Women's Studies Quarterly, 28*(1/2), 271-295.

Giroux, H. (2004). Critical theory and the politics of culture and voice: Rethinking the discourse of educational research. In R. Serman, & R. Webb, (Eds.), *Qualitative research in education* (pp. 190-211). London, England, UK: Routledge.

Giroux, H., & Cohen, R. (2014). *Neoliberalism's war on higher education.* Chicago, IL: Haymarket Books.

Giroux, H., & Giroux, S. (2004). *Take back higher education: Race, youth, and the crisis of democracy in the post-civil Rights Era.* New York, NY: Palgrave Macmillan.

Glimore, S. (2015, January 22). Canada's race problem? It's even worse than America's. *Macleans.* Retrieved from http://www.macleans.ca/news/canada/out-of-sight-out-of-mind-2/

Goldberg, D. (2005). Postracial states. In G. Fischman, (Ed.), *Critical theories, radical pedagogies, and global conflicts* (pp. 115-135). Toronto, ON: Rowman & Littlefield.

Goldberg, D.E., Somerville, M., & Whitney, C. (2014). *A whole new engineer: The coming revolution in engineering education*. Douglas, MI: Threejoy Associates, Inc.

Golding, C. (2011). Educating for critical thinking: Thought-encouraging questions in a community of inquiry. *Higher Education Research & Development, 30*(3), 357-370.

Goldberg, L. (1990). An alternative "description of personality": The big-five factor structure. *Journal of Personality and Social Psychology, 59*(6), 1216-1229.

Goldberg, D.E., & Somerville, M. (2015). The making of a whole new engineer: Four unexpected lessons for engineering educators and education researchers. *Journal of Engineering Education, 104* (1), 2-6.

Goldring, L., Berinstein, C., & Bernhard, J. (2009). Institutionalizing precarious migratory status in Canada. *Citizenship Studies, 3*(19), 239-265.

Goldschmid, B., & Goldschmid, M. (1976). Peer teaching in higher education: A review. *Higher Eudcation, 5*(1), 9-33.

Gopal, A. (2016). Academic experiences of international graduate students: The Canadian perspective in the context of internationalization. In K. Bista, & C. Foster, (Eds.), *Exploring the Social and Academic Experiences of International Students in Higher Education Institutions* (pp. 21-37). Hershey, PA: IGI Global.

Gosser, D., Kampmeier, J., & Varma-Nelson, P. (2010). Peer-led team learning: 2008 James Flack Norris Award Address. *Journal of Chemical Education, 87*(4), 374-380.

Government of Alberta. (2013). *Building Alberta: Budget 2013 keeps the focus on students.* Retrieved from http://alberta.ca/release.cfm?xID=3378046B3A890-A09D-D222-DB9B59897D97B1AF

Government of Canada. (2016, February 23). *Post-secondary education.* Retrieved from Government of Canada: Education: http://www.aadnc-aandc.gc.ca/eng/110010 0033679/1100100033680

Government of Newfoundland & Labrador. (2016a). *Budget 2016.* Retrieved from Newfoundland & Labrador : http://www.budget.gov.nl.ca/budget 2016 /default.htm

Government of Newfoundland & Labrador. (2016b). *Our fiscal future: Starting the conversation.* St. John's, NL: Author.

Government of Ontario. (2014). *Public sector salary disclosure 2014 (Disclosure of 2013).* Ministry of Finance, Ottawa, ON: Author.

Graham, G. (2010). *Behaviorism.* Retrieved from The Stanford Encyclopedia of Philosophy: http://plato.stanford.edu/archives/fall2010 /entries/behaviorism

Graham, W. (2000). Academic freedom or commerical licence? In J. Turk, (Ed.), *Corporate campus: Commercializatin and the dangers to Canada's colleges and universities* (pp. 23-31). Toronto, ON: James Lorimer and Company Ltd.

Grande, S. (2007). Red Lake Woebegone: Pedagogy, decolonization, and the critical project. In P. McLaren, & J. Kincheloe, (Eds.), *Critical Pedagogy: Where are we now?* (pp. 315-337). New York, NY: Peter Lang.

Grant, L., Kennelly, I., & Ward, K. (2000). Revisiting the gender, marriage, and parenthood puzzle in scientific careers. *Women's Studies Quarterly*, *28*(1/2), 62-85.

Grasso, D., & Burkins, M.B. (Eds.) (2010). *Holistic engineering education: Beyond technology*. New York, NY: Springer.

Green, D., & Riddell, C. (2012). *Ageing and literacy skills: Evidence from Canada, Norway and the United States, Working Paper No. 98.* Toronto, ON: Canadian Labour Market and Skills Researcher Network (CLSRN).

Green, J.A., Yu, S.B. (2015). Educating critical thinkers. *Policy Insights from the Behavioral and Brain Sciences, 3*(1), 45-53.

Grinter, L. (1955). Summary of the report on the evaulation of engineering education. *Engineering Education*, *46*, 25-60.

Gunnlaugson, O. (2007). Shedding light on the underlying forms of transformative learning theory: Introducing three distinct categories of consciousness. *Journal of Transformative Education, 5*(2), 131-151.

Guruz, K. (2011). *Higher education and international student mobility in the global knowledge economy.* Albany, NY: State University of New York Press.

Habermas, J. (1971). *Knowledge and human interests*. (J. Shapiro, Trans.). London, England: Heinemann.

Hall, B. (2000). Breaking the educational silence: For seven generations, an information legacy of the royal commission on aboriginal peoples. In B. Hall, G. Dei, & D.

Rosenberg, (Eds.), *Indigenous knowledges in global contexts: multiple readings of our world* (pp. 202-215). Toronto, ON: University of Toronto Press.

Hall, B., Dei, G., & Rosenberg, D. (Eds.). (2000). *Indigenous knowledges in global contexts: multiple readings of our world.* Toronto, ON: University of Toronto Press.

Hall, S. (1989). Cultural identity and cinematic representation. *Framework*, *0*(36), 68-82.

Hall, S. (1997). *Representation: cultural representations and signifying practices.* London, England: SAGE.

Hamilton, L., & Corbett-Whittier, C. (2013). *Using case study in education research*. London, England: SAGE.

Hammers, C. (2016). Queer. In A. Goldberg, (Ed.), *The SAGE encyclopedia of LGTBQ studies* (Vol. 3, pp. 907-908). Thousand Oaks, CA: SAGE.

Harding, T., Carpenter, D., & Finelli, C. (2012). An exploratory investigation of the ethical behavior of engineering undergraduates. *Journal of Engineering Education*, *101*(2), 346-374.

Hardt, M., & Negri, A. (2000). *Empire.* Cambridge, MA: Harvard University Press.

Harpham, G. (2011). From Eternity to Here: Shrinkage in American Thinking About Higher Education. *Representations*, 42-61.

Harrison, N. (2004). Rethinking critical thinking: Indigenous students studying at university. *Teaching Education, 115*(4), 375-384.

Harsin, J. (2015). Regimes of posttruth, postpolitics, and attention economies. *Communication, Culture & Critique, 8*(2), 327-333.

Hatherly, D. (2015, January 20). Manitoba's council on post-secondary education dissolved. *The Manitobian*. Retrieved from http://www.themanitoban.com /2015/01/manitoba-government-education-council-post-secondary-education-dissolved/22249/

Henkel, M., & Vabo, A. (2006). Academic identities. In Kogan, M. Henkel, M. Bauer, M., & Bleiklie, I. (Eds.), *Transforming higher education* (2nd ed., Vol. 13, pp. 127-159). Dordrecht, The Netherlands: Springer .

Henry, F., & Tator, C. (2010). *The colour of democracy: Racism in Canadian society* (4th ed.). Toronto, ON: Nelson Education.

Henry, F., & Tator, C. (2012). Interviews with racialized faculty members in Canadian universities. *Canadian Ethnic Studies*, *44*(2), 75-99.

Hermann, R. (2014, June 1-4). *The engineering access program for Indigenous (First Nation/Metis/Inuit) students.* Paper presented at the IEEE Canada International Humanitarian Technology Conference, Quebec. Montreal, QC: IEEE.

Hidalgo, D.A., & Barber, K. (2017). Queer. In *Encyclopædia Britannica*. Retrieved from https://www.britannica.com/topic/queer-sexual-politics

Hogan, J. & Hogan, R. (2004). Big five personality traits. In G. Goethals, G. Sorenson, & J. MacGregor Burns (Eds.), *Encyclopedia of Leadership* (pp. 96-100). Thousand Oaks, CA: SAGE.

hooks, b. (1994). *Teaching to transgress: Education as the practice of freedom.* New York, NY: Routledge.

hooks, b. (2003). *Teaching community: A pedagogy of hope.* New York, NY: Routledge.

Hooks, b. (2010). *Teaching critical thinking: Practical wisdom*. New York, NY: Routledge.

Hornsby, D., & Osman, R. (2014). Massification in higher education: Large classes and student learning. *The International Journal of Higher Education and Educational Planning, 67*(6), 711-719.

House Committee on Education and the Workforce. (2014). *The just-in-time professor: a staff report summarizing eforum responses on the working conditions of contingent faculty in higher education.* Washington, D.C: U.S. House of Representatives.

Howells, L. (2015, May 30). Tuition no longer frozen for MUN's international and graduate students. *The Muse*. Retrieved from http://themuse.ca/2015/04/30/ tuition-no-longer-frozen-for-muns-international-and-graduate-students/

Hughes, D.M. (2000). Scientific, feminist, and personal epistemologies: Conflicts and opportunities. *Women's Studies Quarterly, 28*(1/2), 305-312.

Hull, J. (2005). *Post-secondary education and labour market outcomes canada, 2001.* Ottawa, ON: Minister of Indian Affairs and Northern Development.

Humphries, J., Knight-Grofe, J., & Klabunde, N. (2009). *Canada first: The 2009 survey of international students.* Ottawa, ON: Canadian Bureau for International Education.

Hutcheson, P., Gasman, M., & Sanders-McMuty, K. (2011). Race and equality in the academy: Rethinking higher education actors and the struggle for equality in the post-world war ii period. *The Journal of Higher Education*, *82*(2), 121-153.

Hynes, H. (2000). Toward a laboratory of one’s own: Lesbians in science. *Women's Studies Quarterly, 28*(1/2), 158-164.

IEEE. (2016, April 25). *Education & Careers.* Retrieved from IEEE: Advancing Technology for Humanity: https://www.ieee.org/education_careers/index.html

International Center for Supplemental Instruction. (2012). *Other SI Programs.* Retrieved from http://www.umkc.edu /cad/si/programs.shtml

James, C., & Taylor, L. (2008). "Education will get you to the station": Marginalized students' experiences and perceptions of merit in accessing university. *Canadian Journal of Higher Education, 31*(3), 567-590.

Jarvis, D. (2014). Regulating higher education: Quality assurance and neo-liberal managerialism in higher education: A critical introduction. *Policy and Society, 33,* 155-166.

Jia, J., Zhang, P., & Zhang, R. (2015, September 23-25). *A Comparative Study of Three Personality Assessment Models in Software Engineering Field.* Paper presented at the IEEE Software Engineering and Service Science 6th International Conference, China. Beijing, China: IEEE.

Johnson, M., Pizzolato, J., & Kanny, M. (2015). Examining the significance of “race” in college students’ identity within a “postracial” era. *Journal of College Student Development, 56*(3), 227-242.

Joyce, T., & Hopkins, C. (2014). 'Part of the Community?' First year international students and their engineering teams. *Engineering Education, 9*(1), 18-32.

Kapitulik, B., Hilton, K., & Clawson, D. (2007). Critical experiential pedagogy: sociology and the crisis in higher education. *American Sociologist, 38*(2), 135-158.

Katz, J. (2013). Value diversity and inclusion: Leveraging differences for bottom-line success. In Carter, L.G. (Ed.), *The change champion's field guide* (pp. 445-462). Somerset, England: Center for Creative Leadership.

Kaufmann, J. (2010). The practice of dialogue in critical pedagogy. *Adult Education Quarterly, 60*(5), 194-199.

Keirsey, D. (1998). *Please understand me II: Temperament, character, intelligence*. Del Mar, CA: Prometheus Nemesis.

Keller, T. (2009, January 14). Another university president without a Ph.D. *Maclean's*. Retrieved from http://www.macleans.ca/education/uniandcollege/another-university-president-without-a-phd/

Kent, E. (2012). What are you going to do with a degree in that? Arguing for the humanities in an era of efficiency. *Arts & Humanities in Higher Education, 11*(3), 273-284.

Keyes, R. (2004). *The post-truth era: Dishonesty and deception in contemporary life.* New York, NY: St. Martin's Press.

Kilgore, D. (2001). Critical and postmodern perspectives on adult learning. *New Directions for Adult and Continuing Education, 89,* 53-61.

Kilgore, D. (2004). Toward a postmodern pedagogy. *New Directions for Adult and Continuinng Education, 102*, 45-53.

Kimchi, J., Polivka, B., & Stevenson, J. S. (1991). Triangulation: Operational definitions. *Nursing Research, 40*(6), 364-6.

Kincheloe, J.L. (2004). *Critical pedagogy primer*. New York, NY: Peter Lang Publishing Inc.

Kincheloe, J.L. (2008). *Knowledge and critical pedagogy*. London, England: Springer.

Kitchenham, A. (2008). The evolution of John Mezirow's transformative learning theory. *Journal of Transformative Education*, *6*(2),104-123.

Klikauer, J. (2015). Critical management studies and critical theory: A review. *Capital & Class (39)*2, 197-220.

Kotys-Schwartz, D., Knight, D., & Pawlas, G. (2010, June 20-23). *First-year and capstone design projects: Is the bookend curriculum approach effective for skill gain?*. Paper presented at Proceedings of the ASEE Annual Conference Exposition, Kentucky. Louisville, KY: IEEE.

Krathwohl, D. (2002). A revision of Bloom's Taxonomy: An overview. *Theory Into Practice, 41*(4), 214-264.

Kress, T. (2011a). Inside the 'thick wrapper'of critical pedagogy and research. *International Journal of Qualitative Studies in Education, 24*(3), 267-283.

Kress, T. (2011b). Stepping out of the academic brew: Using critical research to break down hierarchies of knowledge production. *International Journal of Qualitative Studies in Education, 24*(3), 267-286.

Kristeva, J. (1981). Women's time (A. Jardine and H. Blake, Trans.). *Signs: Journal of Women in Culture and Society 7*(1), 13-35.

Krugman, P. (2011, December 22). The post-truth campaign. *New York Times*. Retrieved from http://www.nytimes.com/2011/12/23/opinion/krugman-the-post-truth-campaign.html

Kuokkanen, R. (2007). *Reshaping the university: Responsibility, Indigenous epistemes, and the logic of the Gift.* Vancouver, BC: UBC Press.

Lather, P. (1991). *Getting smart: Feminist research and pedagogy with/in the postmodern*. New York, NY: Routledge.

Lauckner, H., Paterson, M., & Krupa, T. (2012). Using constructivist case study methodology to understand community development processes: Proposed methodological questions to guide the research process. *The Qualitative Report, 17(*13), 1-22.

Laroche, J. (2015, April 22). *Nova Scotia universities face increased financial scrutiny with new bill.* Retrieved from http://www.cbc.ca/news/canada/nova-scotia/nova-scotia-universities-face-increased-financial-scrutiny-with-new-bill-1.3044608

Lax, J., & 2014. (2015, July 12-15). *Laying a foundation for academic writing in engineering: Helping international graduate students write in English.* Paper presented at the IEEE International Professional Communication Conference, Ireland. Limerick, Ireland: IEEE.

Le, T., & Gardner, S. (2010). Understanding the doctoral experience of asian international students in the science, technology, engineering, and mathematics (STEM) fields: An exploration of one institutional context. *Journal of College Student Development, 51*(3), 252-264.

Lee, J. (2007). Neo-racism toward international students: A critical need for change. *About Campus, 11*(6), 28-30.

Leland, K., & Bailey, K. (2006). *Customer service for dummies* (3rd ed.). Hoboken, NJ: John Wiley & Sons.

Leicester, M. (2000). Post-postmodernism and continuing education. *International Journal of Lifelong Education, 19*(1), 73-81.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Beverly Hills, CA: Sage Publications.

Lockenhoff, C., & Costa, P. (2007). Big Five Personality Traits. In R. Baumeister, & K. Vohs (Eds.), *Encyclopedia of Social Psychology* (pp. 116-117). Thousand Oaks, CA: SAGE.

Long, J. (2008, March 6). *White season.* Retrieved from http://news.bbc.co.uk /2/hi/programmes/newsnight/7281314.stm

Maken, T. (2013). *Adaption of international engineering students in project based learning environment: A transformative learning experiences.* Paper presented at

Proceedings of the 2013 IEEE Global Engineering Education Conference, Germany. Berlin, Germany: IEEE.

Malkki, K. (2011). Rethinking disorienting dilemmas within real-life crises: The role of reflection in negotiating emotionally chaotic experiences. *Adult Education Quarterly, 62*(3), 207-229.

Mandler, G. (2002). Origins of the cognitive (r)evolution. *Journal of the History of Behavioral Sciences, 38*(4), 339-353.

Margolis, J. F. (2000). The anatomy of interest: Women in undergraduate computer science. *Women's Studies Quarterly, 28*(1/2), 104-127.

Maringe, F., & Foskett, N. (2010). *Globalization and internationalization in higher education: Theoretical, strategic and management perspectives*. New York, NY: Continuum.

Maringe, F., & Sing, N. (2014). Teaching large classes in an increasingly internationalising higher education environment: Pedagogical, quality and equity issues. *Higher Education, 67*, 761-782.

Martin, C. (2016, July 1). *Judging and percieving*. Retrieved from Myers Briggs Foundation http://www.myersbriggs.org/my-mbti-personality-type/mbti-basics/judging-or-perceiving.htm

Matthews, D. (2012, November 8). *For US, recruiting the usual suspects is not enough.* Retrieved from http://www.timeshighereducation.co.uk/news/for-us-recruiting-the-usual-suspects-is-not- enough/421744.article

Matthews, D. (2013, January 24). *Visa 'rhetoric' a sorry business for the UK.* Retrieved from http://www.timeshighereducation.co.uk/visa-rhetoric-a-sorry-business-for-the-uk/2001083.article

Mayer, R. (1999). *The promise of educational psychology.* Upper Saddle River, NJ: Prentice-Hall.

Mayes, T. (2014). *Campus climate and the underrepresented minority engineering student experience: A critical race study.* Ann Arbor, MI: UMI Dissertation Publishing.

Maxwell, J.A., (2013). *Qualitative Research Design.* Los Angeles/London: SAGE.

McArthur, J. (2010a). Achieving social justice within and through higher education: The challenge for critical pedagogy. *Teaching in Higher Education, 15*(5), 493-504.

McArthur, J. (2010b). Time to look anew: Critical pedagogy and disciplines within higher education. *Studies in Higher Education, 35*(3), 301-315.

McCurdy P, & Uldam, J. (2014). Connecting participant observation positions: Toward a reflexive framework for studying social movements. *Field Methods*, *26*(1), 40-55.

McGee, E., & Martin, D. (2011). ‘‘You would not believe what i have to go through to prove my intellectual value!’’ Stereotype management among academically successful black mathematics and engineering students. *American Educational Research Journal, 48*(6), 1347-1389.

McGinnis, J. (2013). Be a skilled communicator: Lead dialogue proccesses to build commitment and reach shared understandings. In L.G. Carter, (Ed.), *The change champion's field Guide* (pp. 205-220). Somerset, England: Center for Creative Leadership.

McGowan, U., Seton, J., & Cargill, M. (1996). A collaborating colleague model for inducting international engineering students into the language and culture of a foreign research environment. *IEEE Transactions on Professional Communications, 39*(3), 117-121.

McIntyre, A. (2008). *Qualitative research methods: Participatory action research.* Thousand Oaks, CA: SAGE.

McIsacc, E. (2000). Oral Narratives as a site of resistance: Indigenous knowledge, colonialism, and western discourse. In B. Hall, G. Dei, & D. Rosenberg, (Eds.), *Indigenous knowledges in global contexts: multiple readings of our world* (pp. 89-102). Toronto, ON: University of Toronto Press.

McLaren, P., & Farahmandpur, R. (2005). *Teaching against global capitalism and the new imperialism: A critical pedagogy.* Toronto, ON: Rowman & Littlefield.

McLaren, P., & Kincheloe, J. (2007). *Critical Pedagogy: where are we now?* New York, NY: Peter Lang.

McMullen, K., & Elias, A. (2011). A changing portrait of international students in Canadian universities. *Education Matters: Insights on education, learning, and training in canada*, *7*(6).

Meacham, S., & Buendia, E. (1999). Modernism, post-modernism, and post-structuralism and their impact on literacy. *Language Arts, 76*(6), 510-516.

Mendelson, M. (2006). *Aboriginal Peoples and Postsecondary Education in Canada.* Ottawa, ON: Caledonian Institute of Social Policy.

Metcalfe, A., Fisher, D., Gingras, Y., Jones, G., Rubenson, K., & Snee, I. (2011). Canada: Perspectives on governance and management. In W. Locke, W. Cummings, & D.

Fisher, (Eds.), *Changing governance and management in higher education: the perspectives of the academy* (pp. 151-174). Dordrecht, The Netherlands: Springer.

Merriam, S. B. (2004). The Role of Cognitive Development in Mezirow's Transformational Learning Theory. *Adult Education Quarterly*, *55*(1), 60-68.

Merriam, S. B. (2009). *Qualitative research: A guide to design and implementation*. (3rd ed). San Francisco, CA: Jossey-Bass.

Merriam, S. B. (2015). Qualitative research: designing, implementing, and publishing a study. In C.X. Wang, (Ed.), *Handbook of Research on Scholarly Publishing and Research Methods* (pp. 125-140), Hershey, PA: IGI Global.

Merriam, S. B., & Bierema, L. L. (2014). *Adult learning: Linking theory and practice*. San Francisco, CA: Jossey-Bass.

Merriam, S. B., Caffarella, R. S., & Baumgartner, L. (2007). *Learning in adulthood: A comprehensive guide*. San Francisco, CA: Jossey-Bass.

Merriam, S.B. & Tisdell, E.J. (2016). *Qualitative research: A guide to design and implementation* (4th ed). San Francisco, CA: Jossey-Bass.

Mezirow, J. (1997). Transformative learning: Theory to practice. *New Directions For Adult and Continuing Education, 74*, 5-12.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. Thousand Oaks, CA: SAGE.

Miller, R. (2014). The future of engineering education. *Research & Technology Management*, *57*(1), 15-19.

Mills, S. (2007). Higher education's role in preparing educators in critical pedagogy for social justice. *The International Journal of Knowledge, Culture, and Change Management, 5*(6), 131-140.

Mills, A. J., Wiebe, E., & Durepos, G. (2010). *Encyclopedia of case study research*. Thousand Oaks, CA: SAGE.

Ministry of Training, Colleges and Universities. (2015). *Focus on outcomes, centre on students: Perspectives on evolving ontario's university funding model.* Ottawa, ON: Service Ontario.

Ministry of Training, Colleges and Universities. (2013). *Ontario's differentiation policy framework for postsecondary education.* Ottawa, ON: Queen's Printer for Ontario.

Morland, I.; Willox, A. (2005). *Queer Theory*. London, England: Palgrave Macmillan

Moretto, L.H. (1995, September 27-29). *Who are we? Why do we act the way we do? An Overview of the Myers Briggs Personality Type Indicator*. Paper presented at the IEEE International Professional Communication Conference, Georgia. Savannah, GA: IEEE.

Moore, M.J. (2005). The transtheoretical model of the stages of change and the phases of transformative learning: Comparing two theories of transformational change. *Journal of Transformative Education, 3*(4), 394-415.

Mulqueen, C. (2012). *Technical Report: Social Style & Versatility.* TRACOM Corporation. Retrieved from https://www.tracomcorp.com/wp-content/uploads/2014/01/SocialStyle-Research-TechnicalReport.pdf

Mulryan-Kyne, C. (2010). Teaching large classes at college and university level: Challenges and opportunities. *Teaching in Higher Education*, *15*(2), 175-185.

Mwangi, C., Peralta, A., Fries-Britt, S., & Daoud, N. (2016). Academic motivation and experiences of students of colour in STEM. In K. Bista, & C. Foster, (Eds.), *Exploring the social and academic experiences of international students in higher education institutions* (pp. 197-211). Hershey, PA: IGI Clobal.

Nadal, K. (2014). The adverse impact of racial microaggressions on college students' self-esteem. *Journal of College Student Development, 55*(5), 461-474.

Narli, S. (2010). An alternative evaluation method for likert type attitude scales: rough set data analysis. *Scientific Research And Essays, 5*(6), 519-528.

Naylor, D. (2012, October 3). *The University of Toronto's response to the MTCU discussion paper.* Retrieved from http://www.president. utoronto.ca/speeches/the-university-of-torontos-response-to-the-mtcu-discussion-paper

Neave, G. (Ed.). (2006). *Knowledge, power and dissent: Critical perspectives on higher education and research in knowledge society*. Paris, France: UNESCO Publishing.

Nesbit, T. (2005), Social class and adult education. *New Directions for Adult and Continuing Education, 106*, 5-14.

Newberry, B., Austin, K., Lawson, W., Gorsuch, G., & Darwin, T. (2011). Acclimating international graduate students to professional engineering ethics. *Science and Engineering Ethics, 17*, 171-194.

Noble, D. (2000). Digitial diploma mills: Rehearsal for the revolution. In J. Turk, (Ed.), *The Corporate campus: Commercialization and the dangers to Canada's colleges and universities* (pp. 101-123). Toronto, ON: James Lorimer & Company Limited.

Nolan, K. (2010). Praxis. In Durepos, G., Mills, A. J., & Wiebe, E. (Eds.) *Encyclopedia of case study research* (Vol. 2, pp. 725-728). Los Angeles, CA: SAGE.

Norton, M., & Sommers, S. (2011). Whites see racism as a zero-sum game that they are now losing. *Perspectives on psychological science*, *6*(3), 215-218.

Nova Scotia Legislature. (2015, April 22). Bill 100: Universities Accountability and Sustainability Act. Halifax, NS: Government of Nova Scotia.

Novak, J. (2011). A theory of education: Meaningful learning underlies the cognitive integration of thinking, feeling, and acting leading to empowerment for commitment and responsibility. *Meaningful Learning Review, 1*(2), 1-14.

Novak, J., & Canas, A. (2008). *The theory underlying concept maps and how to construct and use them.* Florida Institute for Human and Machine Cognition. Retrieved from http://cmap.ihmc.us/Publications/ResearchPapers/Theory

NSFL. (2015, April 24). Media release: Joint Statement Against Bill 100. Retrieved from Nova Scotia Federation of Labour: http://nslabour.ca/2015/04/media-release-joint-statement-bill-100/

OCUFA. (2010, October 27). *OCUFA Response to the HEQCO differentiation report.* Retrieved from https://realacademicplanning. wordpress.com /2010/10/26/ocufa-response-to-the-heqco-differentiation-report-26-october-2010/

OCUFA. (2013, December 10). *Ontario's differentiation policy framework: OCUFA's analysis.* Retrieved from http://ocufa.on.ca/blog-posts/politics/ontarios-differentiation-policy-framework-ocufas-analysis/

OECD. (2017, June 1). *Educational attainment and labour market outcomes by skills.* Retrieved from Organization for Economic Cooperation and Development: http://stats.oecd.org/#

Omar, J. (2010). *The importance of academic advising and its intervention action in advising students who are near the border of passing or failing an engineering program.* Paper presented at the proceedings of the 2nd International Congress on Engineering Education, Malaysia. Kuala Lumpur, Malaysia: IEEE.

Omi, M., & Winant, H. (1994). *Racial formation in the United States: From the 1960s to the 1980s* (2nd ed.). New York, NY: Routledge.

O'Neill, G., & McMahon, T. (2005). Student-centered learning: What does it mean for students and lecturers? In O'Neill, G., Moore, S., McMullin, B. (Eds.), *Emerging issues in the practice of university learning and teaching.* Dublin, Ireland: All Ireland Society for Higher Education (AISHE).

Ontario Ministry of Training, Colleges and Universities. (2016, April 1). *Postsecondary education partners' gateway*. Retrieved from http://www.tcu.gov.on.ca/ pepg/audiences/universities/uff/

Ostrom, C., Martin, W., & Zacharakis, J. (2008). Autopoiesis and the cosmology of postmodern adult education. *Adult Education Quarterly: A Journal of Research and Theory, 58*(4), 299-317.

Owen, G. T. (2014). Qualitative methods in higher education policy analysis: Using interviews and document analysis. *The Qualitative Report, 19*(26), 1-19

Paechter, M., & Maier, B. (2010). Online or face-to-face? Students' experiences and preferences in e-learning. *Internet and Higher Education, 13*(4), 292-297.

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

Phillips, J., & Hausbeck, K. (2000). Just beneath the surface: Rereading geology, rescripting the knowledge-power nexus. *Women's Studies Quarterly, 28*(1/2), 181-202.

Pilkington, A. (2013). The interacting dynamics of institutional racism in higher education. *Race ethnicity and education, 16*(2), 225-245.

Pio, E. T., Rasheed, A., & Parker, L. (2014). Te Wero – the challenge: Reimagining universities from an Indigenous world view. *Higher Education, 67*(5), 675-690.

Pitts, K. (2017). *iFoundry legacy continues in AE3.* Retrieved from http://ae3. engineering.illinois.edu/ifoundry-legacy-continues-in-ae3/

Poolokasingham, G., Spanierman, L., Kleiman, S., & Houshmand, S. (2014). Fresh off the boat?" Racial microaggressions that target South Asian Canadians. *Journal of Diversity in Higher Education, 7*(3), 194-210.

Powell, W.W., & Snellman, K. (2004). The knowledge economy. *Annual Review of Sociology, 30*, 199-220.

PRRI. (2014, June 10). *Americans' racial disconnect on fairness and discrimination.* Retrieved from http://publicreligion.org /2014/10/ graphic-of-the-week-americans-racial-disconnect-on-fairness-and-discrimination/# .VzjLOPkrJD_

Quenk, N. (2016). *The fourth or inferior function*. Retrieved from the Myers Briggs Foundation http://www.myersbriggs.org/my-mbti-personality-type/understanding-mbti-type-dynamics/the-fourth-or-inferior-function.htm

Quinless, J.M. (2006). *Aboriginal women: Education and major fields of study*. Ottawa, ON: Aboriginal Affaris and Northern Development Canada: Strategic Research Directorate.

Quinn, R. (1996). *Deep change: Discovering the leader within.* San Francisco, CA: Jossey-Bass.

Rand, E. (2014). Reclaiming queer: Activist & academic rhetorics of resistance. Tuscaloosa, AL: The University of Alabama Press.

Rappolt, M. (2013, November 13). Trent University president Steven Franklin opens up about Ontario's differentiation policy proposal. *Arthur*. Retrieved from http://trentarthur.ca/trent-university-president-steven-franklin-opens-up-about-ontarios-differentiation-policy-proposal/

Rayman, P. &., & Stewart, J. (2000). Reaching for success in science: Women's uneven Journey. *Women's Studies Quarterly*, *28*(1/2), 13-23.

Rebora, G., & Turri, M. (2010). Change management in universities: More a question of balance than a pathway. *Tertiary Education and Management*, *16*(4), 285-302.

Reissman, C. K. (2004). Narrative analysis. In M.S. Lewis-Beck, A. Bryman, & T. Futing Liao, (Eds.), *Encyclopedia of Social Science Research Methods* (pp. 705- 709). Newbury Park, CA: SAGE.

Reuben, E., Sapienza, P., & Zingales, L. (2014). How stereotypes impair women's careers in science. *Proceedings of the National Academy of Sciences*, *111*(12), 4403-4408.

Rhoads, G. and Slaughter, S. (2006). Academic capitalism and the new economy: privatization as shifting the target of public subsidy in higher education. In R.A. Rhoads, & C.A. Torres, (Eds.), *The university, state and market: the political economy of globalization in the Americas* (pp. 103–140). Stanford, CA: Stanford University Press.

Ridley, C., & Kelly, S. (2006). Institutional racism. In Y. Jackson, (Ed.), *Encyclopedia of multicultural psychology* (pp. 256-257). Thousand Oaks, CA: SAGE.

Riley, D. (2008). Engineering and Social Justice. *Synthesis lectures on engineers, technology, and society*, *3*(1), 1-152.

Rosati, P. (1997, November 5-7). *Students' psychological type and success in different engineering programs.* Paper presented at the IEEE: Frontiers in Education 27th Annual Conference, Philadelphia. Pittsburgh, PA: IEEE.

Roslyn Kunin & Associates, Inc. (2012). *Economic impact of international education in Canada: An update.* Retrieved from http://www.international.gc.ca/education /report-rapport/economic-impact-economique/index.aspx?view=d

Rosu, L.M.; Barret, B.J.; Wilcox, B.; Herman, G.; Price, R.; DeStefano, L. (2014). Engineering professors who are reengineering their Courses: The iFoundry perspective. In M. Winkelmes, A. Burton, & K. Mays, (Eds.), *Teaching and Research on the Prairie*. (pp. 54-59). Chicago, IL: University of Illinois Press.

Rouse, J. (2006). Power/Knowledge. In G. Gutting, (Ed.), The cambridge companion to Foucault (2nd ed., pp. 95-123). Cambridge, England: Cambridge University Press.

Rowe, S. (2007). A humanities response to managerialism: Diversity, democracy, and liberal education in the shade. *International Journal of the Humanities, 5*(8), 95-102.

Roy, H., & Morgan, M. J. (2008). Indigenous languages and research universities: Reconciling world views and Ideologies. *Canadian Journal of Native Education, 31*(1), 232-247.

Russell, L. (2005). It's a question of trust: balancing the relationship between students and teachers in ethnographic fieldwork. *Qualitative Research*, 181-199.

Sambrook, R. (2012). *Delivering trust: Impartiality and objectivity in the digital age.* Oxford: Reuters Institute for the Study of Journalism. Retrieved from http://orca.cf.ac.uk/33772/1/ Delivering_Trust_Impartiality_and_ Objectivity_ in_a_Digital_Age.pdf

Samuel, J., & Karam, A. (2000). Employment equity for visible minorities. In L. Driedger, & S. Halli, (Eds.), *Race and racism: Canada's challenge* (pp. 134-152). Montreal, QC: McGill-Queen's University Press.

Sarkan, M., & Nemec, R. (2010). Humanistic paradigms of education in the postmodern vision. *Journal of Pedagogy, 1*(2), 99-119.

Schofer, E., & Meyer, J. (2016). The worldwide expansion of higher education in the twentieth century. *American Sociological Review, 70*(6), 898-920.

Schwandt, T. A. (2007). *The SAGE dictionary of qualitative inquiry*. Los Angeles, CA: SAGE.

Scott, W. (2010). Reflections: The past and future of research on institutions and institutional change. *Journal of Change Management, 10*(1), 5-21.

Senate of Canada. (2011, December). *Opening the door: reducing barriers to post-secondary education in Canada.* Ottawa, ON: Senate Standing Committe on Social Affairs, Science, and Technology.

Serebrin, J. (2011, June 29). How much does your university's president make? *Macleans*. Retrieved from http://www.macleans.ca/education/uniandcollege/how-much-does-your-universitys-president-make/

Settles, I. H. (2006). The climate for women in academic science: The good, the bad, and the changeable. *Psychology of Women Quarterly, 30*(1), 47-58.

SFU. (2016). *Aboriginal university prep program.* Retrieved from https://www.sfu.ca/continuing-studies/programs/aboriginal-university-preparation-program/why-this-program.html

Shannon-Little, T. (2012). Developing the multicultural community of practice: Starting at induction. In J. Ryan (Ed.), *Cross-cultural teaching and learning for home and international students: Internationalisation of pedagogy and curriculum in higher education* (pp. 265-278). London, England: Routledge.

Sharpe, A., & Arsenault, J. (2010). *Investing in aboriginal education in Canada: An economic perspective.* Ottawa, ON: Centre for the Study of Living Standards.

Shen, H. (2013). Mind the gap: Gender bias in STEM. *Nature, 495*, 22-24.

Sheppard, S., Macatangay, K., Colby, A., & Sullivan, W. (2009). *Educating engineers: Designing for the future of the field.* San Francisco, CA: Jossey-Bass.

Sherman, R.R., & Webb, R.B. (1988). *Qualitative research in education: Focus and methods*. London, England: Falmer Press.

Shumar, W. (1997) College for sale: A critique of the commodification of higher education. Washington, DC: Falmer Press.

Singer, S., Neilsen, N., & Schweingruber, H. (2012). *Discipline-based education research: Understanding and improving learning in undergraduate science and engineering.* National Research Council: Division of Behavioral and Social Sciences and Education, Committee on the Status, Contributions, and Future Directions of Discipline-Based Education. Washington, DC: National Academies Press.

Slaughter, S., & Leslie, L. L. (1997). Academic capitalism: Politics, policies and the entrepreneurial university. Baltimore, MD.: Johns Hopkins University Press.

Smith, D. (2014). The erosion of university autonomy in manitoba. *Canadian Journal of Educational Administration and Policy,* (154), 1-33. Retrieved from: https://files.eric. ed.gov/fulltext/EJ1026850.pdf

Smith, T. (2007). Piloting an undergraduate course-based peer mentoring program. *STLHE Newsletter, 45*(6). Retrieved from http://www.stlhe.ca/wpcontent/uploads/2011/06/STLHE-Newsletter-45-2007-Winter.pdf

Smith, T. (2008). Integrating undergraduate peer assistants into liberal arts courses: A pilot study. *Innovative Higher Education, 33*(1), 49-63.

Smith, T. (2013). Undergraduate curricular peer mentoring programs: Perspectives on innovation by faculty, staff, and students. Plymouth, England: Lexington Books.

Snow, C. (1959). *The two cultures.* London, England: Cambridge University Press.

Spencer, S. (2006). *Race and ethnicity: Culture, identity and representation.* New York, NY: Routeledge .

Stanford, J. (2014, March 29). Canada's transformation under neoliberalism. *Canadian Dimension*. Retrieved from https://canadiandimension.com/articles/view/canadas

Statistics Canada. (2011*a*). *National Household Survey: Number and proportion of the population aged 25 to 64 by highest level of educational attainment, Canada, 2011*. Ottawa, ON: Minister of Industry. Retrieved from https://www12. statcan.gc.ca/nhs-enm/2011/as-sa/99-012-x/2011001/tbl/tbl01-eng.cfm

Statistics Canada. (2011b). *The educational attainment of aboriginal peoples in Canada.* Ottawa, ON: Minister of Industry.

Statistics Canada. (2012). *Public postsecondary enrolments, by registration status, Pan-Canadian Standard Classification of Education (PCSCE), Classification of Instructional Programs, Primary Grouping (CIP_PG), sex and immigration status.* Ottawa, ON: Author. Retrieved from http://www5.statcan.gc.ca/cansim/ pick-choisir;jsessionid=DF43C37

Statistics Canada. (2016). *Aboriginal Identity*. Retrieved from Statistics Canada NHS Dictionary https://www12.statcan.gc.ca/nhs-enm/2011/ref/dict/pop001-eng.cfm.

Statistics Canada. (n.d.). *Table 477-0019* -- *Postsecondary enrolments, by registration status, Pan-Canadian Standard Classification of Education.* Retrieved from CANSIM database: http://www5.statcan.gc.ca/cansim/ a26?lang=e ng &retrLang= eng&id =4770019&pattern=&csid=

Stevenson, M. (2004, April 26). *University governance and autonomy problems in managing access, quality and accountability.* Retrieved from President's Office, Simon Fraser University: https://www.sfu.ca/pres/president/speeches/20045.html

Stewart, R. (2007). Investigating the link between self directed learning readiness and project-based learning outcomes: The case of international Masters students in an engineering management course. *European Journal of Engineering Education, 32*(4), 453-465.

Strydom, J., Zulu, N., & Murray, L. (2004). Quality, culture and change. *Quality in Higher Education, 10*(3), 207-217.

Su, X. (2012). International doctoral science and engineering students: Impact on cohorts' career prospects. *Journal of Studies in International Education, 17*(5), 590-606.

Subramaniam, B. (2000). Snow brown and the seven detergents: A metanarrative on science and the scientific method. *Women's Studies Quarterly, 28*(1/2), 296-304.

Sue, D. W., Capodilupo, C. M., Torino, G. C., Bucceri, J., Holder, A., Nadal, K. L., & Esquilin, M. (2007). Racial microaggressions in everyday life: Implications for clinical practice. *American Psychologist, 62*, 271-286.

Summers, D. (2009, January 2). White working class feels ignored over immigration, says Hazel Blears. *The Guardian.* Retrieved from http://www.theguardian.com /politics/ 2009 /jan/02/ immigration-working-class

Suoranta, J., & Olli-Pekka, M. (2006). Critical pedagogy as collective social expertise in higher education. *International Journal of Progressive Education, 2*(3), 47-64.

Snyder, C. (2012). A case study of a case study: Analysis of a robust qualitative research methodology. *The Qualitative Report, 17*(13), 1-21.

Tang, X. (2014). *Engineering knowledge and student develoment: An institutional and pedagogical critique of engineering education.* Troy, NY: Rensselaer Polytechnic Institute.

Taylor-Vaisey, N. (2008, July 1). All the presidents' contracts: How much does your university president make? The definitive guide. *Macleans*. Retrieved from http://www.macleans.ca /education/uniandcollege/handshakes-aplenty-retiring-presidents-cash-in/

THE. (2016, April 1). World University Rankings 2015-2016. *Times Higher Education.* Retrieved from https://www.timeshighereducation.com/world-university-rankings/2016/ world-ranking#!/page/0/length/25/sort_by/rank_label/sort_ order/asc/cols/rank_only

Tian, M., Lowe, J. (2013). The role of feedback in cross-cultural learning: A case study of Chinese taught postgraduate students in a UK university. *Assessment and Evaluation in Higher Education, 38*(5), 580-598.

Tracy, S. J. (2012). *Qualitative research methods: Collecting evidence, crafting analysis, communicating impact*. Oxford, England: Wiley-Blackwell.

Transformative Learning Centre. (2013). The Transformative Learning Centre. Retrieved http://tlc.oise.utoronto.ca/

Tucker, C. (2000). Promoting success in math among african american female children: A self-empowerment approach. *Women's Studies Quarterly*, *28*(1/2), 143-157.

Turk, J. (2000). Introduction: What commercialization means for education. In J. Turk, (Ed.), *The corporate campus: Commercialization and the dangers to canada's colleges and university* (pp. 3-15). Toronto, ON: James Lorimer & Company Limited.

Turk, J. (2010). The canadian corporate-academic complex. *Academe, 96*(3), 51-53.

Turk, J. (2014, April-June). CAUT's James Turk on corporatized universities. *Peace Magazine.* Retrieved from http://peacemagazine.org/archive/v30n2p08.htm

UBC. (2016, April 28). *First Nations House of Learning.* Retrieved from Aboriginal Portal: http://aboriginal.ubc.ca/longhouse/fnhl/

UC. (2016). *Aboriginal Student Access Program.* Retrieved from Native Centre: http://www.ucalgary.ca/nativecentre/prospective-students/asap

UM. (2016). *Access and Aboriginal Focus Programs.* Retrieved from Extended Education: http://umanitoba.ca/extended/access-afp/

UMKC. (2016). *SI Certification, SI Onsite Training, SI Resources*. Retrieved from The International Center for Supplemental Instruction: http://info.umkc.edu/si/si-onsite-trainings/

UofC Curricular Peer Mentoring Network. (2016). *Programs*. Retrieved from Curricular Peer Mentoring Network: http://peermentoring.ucalgary.ca/programs

Vaidyanathan, R. (2013, February 4). *We don't feel welcome – why aspiring students are thinking twice about the UK.* Retrieved from http://www.bbc.com/news/uk-politics-21461669

Walters, P., & Kop, R. (2009). Heidegger, digital technology, and postmodern education: From being in cyberspace to meeting on myspace. *Science, Technology, Society, 29*(427), 8-28.

Warrick, D. (2013). Developing organization change champions throughout the organization. In Carter, L.G. (Ed.), *The change champion's field guide.* Somerset, England: Center for Creative Leadership.

Weasel, L.H., Honrado, M., & Bautista, D.P. (2000). The forgotten few: Developing curricula on women in the physical sciences and engineering. *Women's Studies Quarterly, 28*(1/2), 251-263.

Weingarten, H., & Deller, F. (2010). *The benefits of greater differentiation of ontario's university sector (final report).* Ottawa, ON: Higher Education Quality Council of Ontario.

Weismiller, B. (2013, March 8). Cuts come as shock to advanced education leaders. *Calgary Herald*. Retrieved from http://www.calgaryherald.com/news/politics/ Cuts+come +shock+advanced+education+leaders/8063332/story.html

Wentzel, K.R. (2014). Commentary: The role of goals and values in critical-analytical thinking. *Educational Psychology Review, 26*, 579-582.

Wierzbicka, A. (2011). Defining 'the humanities'. *Culture Psychology, 17*(1), 31-46.

Wilson, L. (2011). *Social styles handbook: Adapt your style to win trust.* Herentals, Belgium: Nova Vista.

Whitten, B.L., & Burciaga, J.R. (2000). Feminist and multicultural pedagogy in physics: A status report. *Women's Studies Quarterly, 28*(1/2), 212-235.

Williams, B. (2003). Speak for Yourself? Power and hybridity in the cross-cultural classroom. *College Composition and Communication*, *54*(4), 586-609.

Williams, J. C. (2015, March 24). The 5 biases pushing women out of STEM. Retrieved from https://hbr.org/2015/03/the-5-biases-pushing-women-out-of-stem

Willis, J.W. (2007). *Foundations of qualitative research: Interpretive and critical approaches*. Thousand Oaks, CA: SAGE.

Windspeaker. (1994). Group to promote Aboriginal scientists and engineers. *Windspeaker, 12*(3), 10.

Wingrove, J. (2013, April 2). Edmonton mayor calls cuts to universities 'short-term thinking'. *Globe and Mail*. Retrieved from http://www.theglobeandmail.com /news/national/edmonton-mayor-calls-cuts-to-universities-short-term-thinking/article10708935/

Withers, P. (2015, April 30). *Nova Scotia universities law panned as 'heavy-handed'.* Retrieved from http://www.cbc.ca/news /canada/nova-scotia/nova-scotia-universities-law-panned-as-heavy-handed-1.3055556

Wright, S. (2004). Markets, corporations, consumer? New landscapes in higher education. *Learning and Teaching in the Social Sciences, 1*(2), 71-93.

Yakoboski, P., & Foster, J. (2014). *Strategic utilization of adjunct and other contingent faculty*. Retrieved from the Teachers Insurance and Annuity Association of America Institute: https://www.researchgate.net/publication/277010391_ strategic_utilization_of_adjunct_and_other_contingent_faculty

Yoder, J., & Mattheis, A. (2016). Queer in STEM: Workplace experiences reported in a national survey of LGBTQA individuals in science, technology, engineering, and mathematics careers. *Journal of Homosexuality, 63*(1), 1-27.

APPENDIX A: Faculty Survey Consent Form (Online)

Title of Project: "*Innovative Pedagogy: A case study on effective change in higher education"*

Researcher: *K Lord, PhD Candidate, Maple University, klord@MapleU.ca, 222-222-2222*

Supervisors: *Dr. C.B., Faculty of Education, cb@MapleU.ca*
Dr. T.C., Faculty of Business, tc@MapleU.ca
Dr. J.S., Faculty of English, js@MapleU.ca

The proposal for this research has been reviewed by the Interdisciplinary Committee on Ethics in Human Research and found to be in compliance with Maple University's ethics policy. If you have ethical concerns about the research, such as the way you have been treated or your rights as a participant, you may contact the Chairperson of the ICEHR at icehr@MapleU.ca or by telephone at 111-111-1111.

Purpose of the Study

This survey is being conducted within the context of a case study on a pilot program being introduced in the Faculty of Engineering and Applied Sciences at Maple University, a small post-secondary research institution in Canada, which aims to utilize curricular peer mentoring as a pedagogical intervention to address the multitude of internal constraints and stakeholder demands universities contend with at present. Embedded within this case study is likewise a complementary line of inquiry that analyzes the impact of curricular peer mentoring from a critical pedagogy perspective to support women and international students in Canadian universities, while preparing all students for professional engineering practice.

What You Will Be Asked Do

You will be asked to answer 10 survey questions for an approximate total length of 10 minutes. You can choose to complete the survey in one of two ways:

1) Through completion of an online survey. The online survey is being administered by Surveymonkey©, an American software company. As such, your responses are subject to U.S. laws, including the USA Patriot Act. The US Patriot Act allows authorities to access the records of internet service providers. Therefore, anonymity and confidentiality cannot be guaranteed. The risks associated with participation are minimal, however, and similar to those associated with many email programs, such as Hotmail© and social utilities spaces, such as Facebook© and MySpace©. The security and privacy policy for the web survey company can be found at the following link: *https://www.surveymonkey.com/mp/policy/privacy-policy/*.

2) Through completion of a paper copy.

Your participation will remain anonymous and confidential. Should you agree to participate, you will be asked to provide your educational level, faculty association, gender, and age. By completing the survey you will be declaring your consent. You are free to withdraw from the survey at any point prior to this.

What Happens to the Information I Provide?

Information will be reported as appropriate within the university to evaluate courses and programs employing innovative pedagogical practices, and, plan for the support and development of similar programs. Data may also be included in ongoing research of these courses and programs. The research may be reported in scholarly journal articles, books and chapters, or presented at a scholarly conference. In addition, selected quotations (according to conditions above) may be used in Maple University websites, presentations, or public documents. Data will also be used in the doctoral thesis of the researcher which will be publicly available at the MapleU Library.

Data will be stored in locked filing cabinets in the offices of the researcher and in password-protected areas of their computers. Data will be stored indefinitely. The accumulated raw data of any surveys will only be accessible to the members of the research team. If your information is not withdrawn, only the research team or Research Assistants who sign a confidentiality agreement will have access to the collected data.

Questions/Concerns

If you have any further questions or want clarification regarding this research and/or your participation, please contact: K Lord, PhD Candidate, Maple University, klord@MapleU.ca OR Dr. C.B., Assistant Professor, Faculty of Education, Maple University, cb@MapleU.ca. Furthermore, if your participation in this research causes you undue stress or upset you can access the University Counselling Centre at 333-333-3333or the University Health Centre at 444-444-4444.

Consent:

By completing this survey you agree that:

- You have read the information about the research.
- You have been able to ask questions about this study.
- You are satisfied with the answers to all your questions.
- You understand what the study is about and what you will be doing.
- You understand that you are free to withdraw from the study, without having to give a reason, and that doing so will not affect you now or in the future.

You can end your participation by simply closing your browser or navigating away from this page.

However, once you complete this survey and click submit, your data cannot be removed because we are not collecting any identifying information and therefore we cannot link individuals to their responses. By consenting to this online survey, you do not give up your legal rights and do not release the researchers from their professional responsibilities. Please retain a copy of this consent information for your records.

Clicking ACCEPT below and submitting this survey constitutes consent and implies your agreement to the above stipulations.

APPENDIX B: Faculty Survey Consent Form (Print)

Title of Project: "*Innovative Pedagogy: A case study on effective change in higher education*"

Researcher:	*K Lord, PhD Candidate,* *Maple University, klord@MapleU.ca, 222-222-2222*
Supervisors:	*Dr. C.B., Faculty of Education, cb@MapleU.ca* *Dr. T.C., Faculty of Business, tc@MapleU.ca* *Dr. J.S., Faculty of English, js@MapleU.ca*

The proposal for this research has been reviewed by the Interdisciplinary Committee on Ethics in Human Research and found to be in compliance with Maple University's ethics policy. If you have ethical concerns about the research, such as the way you have been treated or your rights as a participant, you may contact the Chairperson of the ICEHR at icehr@MapleU.ca or by telephone at 111-111-1111.

Purpose of the Study

This survey is being conducted within the context of a case study on a pilot program being introduced in the Faculty of Engineering and Applied Sciences at Maple University, a small post-secondary research institution in Canada, which aims to utilize curricular peer mentoring as a pedagogical intervention to address the multitude of internal constraints and stakeholder demands universities contend with at present. Embedded within this case study is likewise a complementary line of inquiry that analyzes the impact of curricular peer mentoring from a critical pedagogy perspective to support women and international students in Canadian universities, while preparing all students for professional engineering practice.

What You Will Be Asked Do

You will be asked to answer 10 survey questions for an approximate total length of 10 minutes. You can choose to complete the survey in one of two ways:

3) Through completion of an online survey. The online survey is being administered by Surveymonkey©, an American software company. As such, your responses are subject to U.S. laws, including the USA Patriot Act. The US Patriot Act allows authorities to access the records of internet service providers. Therefore, anonymity and confidentiality cannot be guaranteed. The risks associated with participation are minimal, however, and similar to those associated with many email programs, such as Hotmail© and social utilities spaces, such as Facebook© and MySpace©. The security and privacy policy for the web survey company can be found at the following link: *https://www.surveymonkey.com/mp/policy/privacy-policy/*.

4) Through completion of a paper copy.

Your participation will remain anonymous and confidential. Should you agree to participate, you will be asked to provide your educational level, faculty association, gender, and age.

What Happens to the Information I Provide?

Information will be reported as appropriate within the university to evaluate courses and programs employing innovative pedagogical practices, and, plan for the support and development of similar programs. Data may also be included in ongoing research of these courses and programs. The research may be reported in scholarly journal articles, books and chapters, or presented at a scholarly conference. In addition, selected quotations (according to conditions above) may be used in Maple University websites, presentations, or public documents. Data will also be used in the doctoral thesis of the researcher which will be publicly available at the MapleU Library.

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Questions/Concerns

If you have any further questions or want clarification regarding this research and/or your participation, please contact: K Lord, PhD Candidate, Maple University, klord@MapleU.ca OR Dr. C.B., Assistant Professor, Faculty of Education, Maple University, cb@MapleU.ca. Furthermore, if your participation in this research causes you undue stress or upset you can access the University Counselling Centre at 333-333-3333or the University Health Centre at 444-444-4444.

Consent:

Completing and submitting this survey means:

- You have read the information about the research.
- You have been able to ask questions about this study.
- You are satisfied with the answers to all your questions.
- You understand what the study is about and what you will be doing.
- You understand that you are free to withdraw from the study without having to give a reason and that doing so will not affect you now or in the future.
- You understand that any data collected from you up to the point of your withdrawal will be destroyed

If you complete this survey, you do not give up your legal rights and do not release the researchers from their professional responsibilities. A copy of this Informed Consent Form has been given to me for my records. **Filling out and submitting this survey constitutes consent and implies your agreement to the above stipulations.**

APPENDIX C: Student Survey Consent Form (Online)

Title of Project: "*Innovative Pedagogy: A case study on effective change in higher education*"

Researcher: *K Lord, PhD Candidate,*
Maple University, klord@MapleU.ca, 222-222-2222

Supervisors: *Dr. C.B., Faculty of Education, cb@MapleU.ca*
Dr. T.C., Faculty of Business, tc@MapleU.ca
Dr. J.S., Faculty of English, js@MapleU.ca

The proposal for this research has been reviewed by the Interdisciplinary Committee on Ethics in Human Research and found to be in compliance with Maple University's ethics policy. If you have ethical concerns about the research, such as the way you have been treated or your rights as a participant, you may contact the Chairperson of the ICEHR at icehr@MapleU.ca or by telephone at 111-111-1111.

Purpose of the Study

This survey is being conducted within the context of a case study on a pilot program being introduced in the Faculty of Engineering and Applied Sciences at Maple University, a small post-secondary research institution in Canada, which aims to utilize curricular peer mentoring as a pedagogical intervention to address the multitude of internal constraints and stakeholder demands universities contend with at present. Embedded within this case study is likewise a complementary line of inquiry that analyzes the impact of curricular peer mentoring from a critical pedagogy perspective to support women and international students in Canadian universities, while preparing all students for professional engineering practice.

What You Will Be Asked Do

You will be asked to answer 10 survey questions for an approximate total length of 10 minutes. You can choose to complete the survey in one of two ways:

5) Through completion of an online survey. The online survey is being administered by Surveymonkey©, an American software company. As such, your responses are subject to U.S. laws, including the USA Patriot Act. The US Patriot Act allows authorities to access the records of internet service providers. Therefore, anonymity and confidentiality cannot be guaranteed. The risks associated with participation are minimal, however, and similar to those associated with many email programs, such as Hotmail© and social utilities spaces, such as Facebook© and MySpace©. The security and privacy policy for the web survey company can be found at the following link *https://www.surveymonkey.com/mp/policy/privacy-policy/*.

6) Through completion of a paper copy.

Your participation will remain anonymous and confidential. Should you agree to participate, you will be asked to provide your educational level, faculty association, gender, and age. By completing the survey you will be declaring your consent. You are free to withdraw from the survey at any point prior to this.

What Happens to the Information I Provide?

Information will be reported as appropriate within the university to evaluate courses and programs employing innovative pedagogical practices, and, plan for the support and development of similar programs. Data may also be included in ongoing research of these courses and programs. The research may be reported in scholarly journal articles, books and chapters, or presented at a scholarly conference. In addition, selected quotations (according to conditions above) may be used in Maple University websites, presentations, or public documents. Data will also be used in the doctoral thesis of the researcher which will be publicly available at the MapleU Library.

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If you have any further questions or want clarification regarding this research and/or your participation, please contact: K Lord, PhD Candidate, Maple University, klord@MapleU.ca OR Dr. C.B., Assistant Professor, Faculty of Education, Maple University, cb@MapleU.ca. Furthermore, if your participation in this research causes you undue stress or upset you can access the University Counselling Centre at 333-333-3333or the University Health Centre at 444-444-4444.

Consent:

By completing this survey you agree that:

- You have read the information about the research.
- You have been able to ask questions about this study.
- You are satisfied with the answers to all your questions.
- You understand what the study is about and what you will be doing.
- You understand that you are free to withdraw from the study, without having to give a reason, and that doing so will not affect you now or in the future.

You can end your participation by simply closing your browser or navigating away from this page.

However, once you complete this survey and click submit, your data cannot be removed because we are not collecting any identifying information and therefore we cannot link individuals to their responses. By consenting to this online survey, you do not give up your legal rights and do not release the researchers from their professional responsibilities.

Please retain a copy of this consent information for your records.

Clicking ACCEPT below and submitting this survey constitutes consent and implies your agreement to the above stipulations.

APPENDIX D: Student Survey Consent Form (Print)

Title of Project: "*Innovative Pedagogy: A case study on effective change in higher education*"

Researcher:	*K Lord, PhD Candidate,* *Maple University, klord@MapleU.ca, 222-222-2222*
Supervisors:	*Dr. C.B., Faculty of Education, cb@MapleU.ca* *Dr. T.C., Faculty of Business, tc@MapleU.ca* *Dr. J.S., Faculty of English, js@MapleU.ca*

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Purpose of the Study

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What You Will Be Asked Do

You will be asked to answer 10 survey questions for an approximate total length of 10 minutes. You can choose to complete the survey in one of two ways:

7) Through completion of an online survey. The online survey is being administered by Surveymonkey©, an American software company. As such, your responses are subject to U.S. laws, including the USA Patriot Act. The US Patriot Act allows authorities to access the records of internet service providers. Therefore, anonymity and confidentiality cannot be guaranteed. The risks associated with participation are minimal, however, and similar to those associated with many email programs, such as Hotmail© and social utilities spaces, such as Facebook© and MySpace©. The security and privacy policy for the web survey company can be found at the following link:. *https://www.surveymonkey.com/mp/policy/privacy-policy/*.

8) Through completion of a paper copy.

Your participation will remain anonymous and confidential. Should you agree to participate, you will be asked to provide your educational level, faculty association, gender, and age.

What Happens to the Information I Provide?

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Questions/Concerns

If you have any further questions or want clarification regarding this research and/or your participation, please contact: K Lord, PhD Candidate, Maple University, klord@MapleU.ca OR Dr. C.B., Assistant Professor, Faculty of Education, Maple University, cb@MapleU.ca. Furthermore, if your participation in this research causes you undue stress or upset you can access the University Counselling Centre at 333-333-3333or the University Health Centre at 444-444-4444.

Consent:

Completing and submitting this survey means:

- You have read the information about the research.
- You have been able to ask questions about this study.
- You are satisfied with the answers to all your questions.
- You understand what the study is about and what you will be doing.
- You understand that you are free to withdraw from the study without having to give a reason and that doing so will not affect you now or in the future.

- You understand that any data collected from you up to the point of your withdrawal will be destroyed

If you complete this survey, you do not give up your legal rights and do not release the researchers from their professional responsibilities. A copy of this Informed Consent Form has been given to me for my records. **Filling out and submitting this survey constitutes consent and implies your agreement to the above stipulations.**

APPENDIX E: Student and Alumni Interview Consent Form

Student / Alumni Consent Form

Title of Project: "*Innovative Pedagogy: A case study on effective change in higher education"*

Researcher: *K Lord, PhD Candidate, Maple University, klord@MapleU.ca, 222-222-2222*

Supervisors: *Dr. C.B., Faculty of Education, cb@MapleU.ca*
Dr. T.C., Faculty of Business, tc@MapleU.ca
Dr. J.S., Faculty of English, js@MapleU.ca

The proposal for this research has been reviewed by the Interdisciplinary Committee on Ethics in Human Research and found to be in compliance with Maple University's ethics policy. If you have ethical concerns about the research, such as the way you have been treated or your rights as a participant, you may contact the Chairperson of the ICEHR at icehr@MapleU.ca or by telephone at 111-111-1111.

This consent form, a copy of which has been given to you, is part of the process of informed consent. If you want more details about something mentioned here, or information not included here, you should feel free to contact the research, Kristina (Kat) Lord. It is entirely up to you to decide whether to take part in this research. If you choose not to take part in this research or if you decide to withdraw from the research once it has started, there will be no negative consequences for you, now or in the future.

Purpose of the Study:
This interview is being conducted within the context of a case study on a pilot program being introduced in the Faculty of Engineering and Applied Sciences at Maple University, a small post-secondary research institution in Canada, which aims to utilize curricular peer mentoring as a pedagogical intervention to address the multitude of internal constraints and stakeholder demands universities contend with at present. Embedded within this case study is likewise a complementary line of inquiry that analyzes the impact of curricular peer mentoring from a critical pedagogy perspective to support women and international students in Canadian universities, while preparing all students for professional engineering practice.

What Will I Be Asked To Do?
Your participation is completely voluntary and may involve any of the following methods. Please let us know which you consent to participate in: (check any or all that you are willing to do, and we will make the arrangements)

___ a personal interview of approximately 20-40 minutes

___ donate a testimonial, a letter of support and/or any other relevant documents you have written, such as course assignments undertaken in classrooms employing innovative pedagogical practices

Please note that your participation in the research is completely voluntary and not related to course credit and will not affect your official status with Maple University. You may refuse to participate altogether. You are free to request more information about the study and you are also free to refuse to answer any specific questions during the data collection process. You have the option of withdrawing at any time during the interview. For interviews and donated documents you may withdraw your materials at any time until 2 weeks after data collection by sending us an email request. If you withdraw, all raw data and documents collected will be destroyed immediately by file erasure and/or shredding.

What Type of Personal Information Will Be Collected?
We may ask you about your age, gender, program of study, year of study, and to name and describe the course you are or were enrolled in that featured non-traditional teaching methods. Letters of support will require your current contact information.

Are there Risks or Benefits if I Participate?
Your participation will assist in data collection about innovative pedagogical practices being employed by educators here at Maple University. You will not be paid or receive any other form of compensation as a direct result of your participation.

Your answers will not affect your official status with the Maple University. If you are a current student, your decision to participate (or not) in the research will have no effect on your grades in any course/program that you may be enrolled in at the Maple University. If you are currently enrolled in a course that you have chosen to provide information about and which is being taught by a member of the research team, your instructor will not have access to any data from their students until their final grades have been submitted.

If you choose to be quoted and cited by your real name, the quotation may have a positive or negative impact on your reputation. Even if you are quoted anonymously, circumstantial details in your data may make you identifiable to readers who also played a role in the course or program you are speaking towards.

What Happens to the Information I Provide?

We will report research according to the anonymity conditions you have chosen below. It will be reported as appropriate within the university to evaluate courses and programs employing innovative pedagogical practices, and, plan for the support and development of similar programs. Data may also be included in ongoing research of these courses and programs. The research may be reported in scholarly journal articles, books and chapters, or presented at a scholarly conference. In addition, selected quotations (according to conditions below) may be used in Maple University websites, presentations, or public documents. Data will also be used in the doctoral thesis of the researcher which will be publicly available at the MapleU Library.

Data will be stored in locked filing cabinets in the offices of the researchers and in password-protected areas of their computers. Data will be stored indefinitely. The accumulated raw data of any interviews will only be accessible to the members of the research team named above and to research assistants who sign a confidentiality statement. The results will be reported only according to the conditions of anonymity and confidentiality that you select; this consent information will be kept with your data. If your information is not withdrawn, only the research team will have access to the collected data.

Anonymity Conditions

For Letters of Support, your letter may be included in presentations and publications of this study and will not be anonymous or confidential. In addition, parts of the letter that are appropriate for public view may also be posted online as a testimonial, and your real name will appear.

For interviews and other documents submitted as research data,

There are several anonymity options for you to consider. You can choose all, some or none of them. Please put a check mark on the corresponding line(s) that grants your permission to:

I grant permission to be audio taped (interview; for data verification only): *Yes:* ___ *No:* ___

I grant permission to be video-taped (interview; for data verification only): *Yes:* ___ *No:* ___

I wish to remain anonymous, but you may refer to me by a pseudonym:* *Yes:* ___ *No:* ___

The pseudonym I choose for myself is: ________________________________

You may quote me and use my name: *Yes:* ___ *No:* ___

*As noted above under "Are there risks or benefits," even if your data is kept anonymous, there is a possibility that your identity will be deduced by circumstantial details known by readers who are familiar with your activities as course names you provide commentary on may be reported.

*By choosing a pseudonym you will be quoted anonymously and referenced by said pseudonym in any reports

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Signatures (written consent)

Your signature on this form indicates that you 1) understand to your satisfaction the information provided to you about your participation in this research project, and 2) agree to participate as a research subject.

In no way does this waive your legal rights nor release the investigators, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from this research project up until two weeks after data collection. You should feel free to ask for clarification or new information throughout your participation.

Participant's Name: (please print)

____

Participant's Signature ____Date:

____

Participants: Please also fill out the anonymity condition choices offered above.

Researcher's Name: (please print)

____

Researcher's Signature: ____Date:

____

Questions/Concerns

If you have any further questions or want clarification regarding this research and/or your participation, please contact: K Lord, PhD Candidate, Maple University, klord@MapleU.ca OR Dr. C.B., Assistant Professor, Faculty of Education, Maple University, cb@MapleU.ca. Furthermore, if your participation in this research causes you undue stress or upset you can access the University Counselling Centre at 333-333-3333or the University Health Centre at 444-444-4444.

APPENDIX F: Faculty/Staff/Administration Interview Consent Form

Faculty/Staff/Administration Consent Form

Title of Project: "*Innovative Pedagogy: A case study on effective change in higher education"*

Researcher: *K Lord, PhD Candidate, Maple University, klord@MapleU.ca, 222-222-2222*

Supervisors: *Dr. C.B., Faculty of Education, cb@MapleU.ca*
Dr. T.C., Faculty of Business, tc@MapleU.ca
Dr. J.S., Faculty of English, js@MapleU.ca

The proposal for this research has been reviewed by the Interdisciplinary Committee on Ethics in Human Research and found to be in compliance with Maple University's ethics policy. If you have ethical concerns about the research, such as the way you have been treated or your rights as a participant, you may contact the Chairperson of the ICEHR at icehr@MapleU.ca or by telephone at 111-111-1111.

This consent form, a copy of which has been given to you, is part of the process of informed consent. If you want more details about something mentioned here, or information not included here, you should feel free to contact the research, Kristina (Kat) Lord. It is entirely up to you to decide whether to take part in this research. If you choose not to take part in this research or if you decide to withdraw from the research once it has started, there will be no negative consequences for you, now or in the future.

Purpose of the Study:
This interview is being conducted within the context of a case study on a pilot program being introduced in the Faculty of Engineering and Applied Sciences at Maple University, a small post-secondary research institution in Canada, which aims to utilize curricular peer mentoring as a pedagogical intervention to address the multitude of internal constraints and stakeholder demands universities contend with at present. Embedded within this case study is likewise a complementary line of inquiry that analyzes the impact of curricular peer mentoring from a critical pedagogy perspective to support women and international students in Canadian universities, while preparing all students for professional engineering practice.

What Will I Be Asked To Do?
Your participation is completely voluntary and may involve any of the following methods. Please let us know which you consent to participate in: (check any or all that you are willing to do, and we will make the arrangements)

___ a personal interview of approximately 20-40 minutes

___ donate a testimonial, a letter of support and/or any other relevant documents you have written, such as course assignments undertaken in classrooms employing innovative pedagogical practices

Please note that your participation in the research is completely voluntary and will not affect your official status with Maple University. You may refuse to participate altogether. You are free to request more information about the study and you are also free to refuse to answer any specific questions during the data collection process. You have the option of withdrawing at any time during the interview. For interviews and donated documents you may withdraw your materials at any time until 2 weeks after data collection by sending us an email request. If you withdraw, all raw data and documents collected will be destroyed immediately by file erasure and/or shredding.

What Type of Personal Information Will Be Collected?
We may ask you about your age, gender, disciplinary concentration, years spent teaching, and to name and describe any courses you teach or know of that feature non-traditional teaching methods. Letters of support will require your current contact information.

Are there Risks or Benefits if I Participate?
Your participation will assist in data collection about innovative pedagogical practices being employed by educators here at Maple University. You will not be paid or receive any other form of compensation as a direct result of your participation.

Your answers will not affect your official status with the Maple University. If you choose to be quoted and cited by your real name, the quotation may have a positive or negative impact on your reputation. Even if you are quoted anonymously, circumstantial details in your data may make you identifiable to readers who also played a role in the course or program you are speaking towards.

What Happens to the Information I Provide?

We will report research according to the anonymity conditions you have chosen below. It will be reported as appropriate within the university to evaluate courses and programs employing innovative pedagogical practices, and, plan for the support and development of similar programs. Data may also be included in ongoing research of these courses and programs. The research may be reported in scholarly journal articles, books and chapters, or presented at a scholarly conference. In addition, selected quotations (according to conditions below) may be used in Maple University websites, presentations, or public documents. Data will also be used in the doctoral thesis of the researcher which will be publicly available at the MapleU Library.

Data will be stored in locked filing cabinets in the offices of the researchers and in password-protected areas of their computers. Data will be stored indefinitely. The accumulated raw data of any interviews will only be accessible to the members of the research team. The results will be reported only according to the conditions of anonymity and confidentiality that you select; this consent information will be kept with your data. If your information is not withdrawn, only the research team or Research Assistants who sign a confidentiality agreement will have access to the collected data.

Anonymity Conditions

For Letters of Support, your letter may be included in presentations and publications of this study and will not be anonymous or confidential. In addition, parts of the letter that are appropriate for public view may also be posted online as a testimonial, and your real name will appear.

For interviews and other documents submitted as research data,

There are several anonymity options for you to consider. You can choose all, some or none of them. Please put a check mark on the corresponding line(s) that grants your permission to:

I grant permission to be audio taped (interview; for data verification only): *Yes:* ___ *No:* ___

I grant permission to be video-taped (interview; for data verification only): *Yes:* ___ *No:* ___

I wish to remain anonymous, but you may refer to me by a pseudonym:* *Yes:* ___ *No:* ___

The pseudonym I choose for myself is: ______________________________

You may quote me and use my name: *Yes:* ___ *No:* ___

*As noted above under "Are there risks or benefits," even if your data is kept anonymous, there is a possibility that your identity will be deduced by circumstantial details known by readers who are familiar with your activities as course names you provide commentary on may be reported.

*By choosing a pseudonym you will be quoted anonymously and referenced by said pseudonym in any reports

Signatures (written consent)

Your signature on this form indicates that you 1) understand to your satisfaction the information provided to you about your participation in this research project, and 2) agree to participate as a research subject.

In no way does this waive your legal rights nor release the investigators, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from this research project up until 2 weeks after data collection. You should feel free to ask for clarification or new information throughout your participation.

Participant's Name: (please print)

____

Participant's Signature ____Date:

____

Participants: Please also fill out the anonymity condition choices offered above.

Researcher's Name: (please print)

____

Researcher's Signature: _______________________________________Date:

____

Questions/Concerns
If you have any further questions or want clarification regarding this research and/or your participation, please contact: K Lord, PhD Candidate, Maple University, klord@MapleU.ca OR Dr. C.B., Assistant Professor, Faculty of Education, Maple University, cb@MapleU.ca. Furthermore, if your participation in this research causes you undue stress or upset you can access the University Counselling Centre at 333-333-3333or the University Health Centre at 444-444-4444.

APPENDIX G: Student Focus Group Consent Form

Student Focus Group Consent Form

Title of Project: "*Innovative Pedagogy: A case study on effective change in higher education*"

Researcher: *K Lord, PhD Candidate,*
Maple University, klord@MapleU.ca, 222-222-2222

Supervisors: *Dr. C.B., Faculty of Education, cb@MapleU.ca*
Dr. T.C., Faculty of Business, tc@MapleU.ca
Dr. J.S., Faculty of English, js@MapleU.ca

The proposal for this research has been reviewed by the Interdisciplinary Committee on Ethics in Human Research and found to be in compliance with Maple University's ethics policy. If you have ethical concerns about the research, such as the way you have been treated or your rights as a participant, you may contact the Chairperson of the ICEHR at icehr@MapleU.ca or by telephone at 111-111-1111.

This consent form, a copy of which has been given to you, is part of the process of informed consent. If you want more details about something mentioned here, or information not included here, you should feel free to contact the research, Kristina (Kat) Lord. It is entirely up to you to decide whether to take part in this research. If you choose not to take part in this research or if you decide to withdraw from the research once it has started, there will be no negative consequences for you, now or in the future.

Purpose of the Study:

This focus group is being conducted within the context of a case study on a pilot program being introduced in the Faculty of Engineering and Applied Sciences at Maple University, a small post-secondary research institution in Canada, which aims to utilize curricular peer mentoring as a pedagogical intervention to address the multitude of internal constraints and stakeholder demands universities contend with at present. Embedded within this case study is likewise a complementary line of inquiry that analyzes the impact of curricular peer mentoring from a critical pedagogy perspective to support women and international students in Canadian universities, while preparing all students for professional engineering practice.

What Will I Be Asked To Do?

Your participation is completely voluntary will ask for your feedback to assess and understand the dynamics of peer mentoring in your course this term by participating in a 'group interview' process wherein you and your peers will be asked a series of questions about your experience with peer mentoring. Your responses help us understand how students engage with peer mentors and how undergraduate education is impacted by the program. Focus groups will be conducted by the researcher and will take 15-30 minutes in total.

Please note that your participation in the research is completely voluntary and will not affect your official status with Maple University. You may refuse to participate altogether. You are free to request more information about the study and you are also free to refuse to answer any specific questions during the data collection process. You have the option of withdrawing at any time during the focus group session. If you withdraw, all raw data and documents collected will be destroyed immediately by file erasure and/or shredding.

What Type of Personal Information Will Be Collected?

We may ask you about your age, gender, disciplinary concentration, year of program, and to name and describe any courses you teach or know of that feature non-traditional teaching methods. Letters of support will require your current contact information.

Are there Risks or Benefits if I Participate?

Your participation will assist in data collection about innovative pedagogical practices being employed by educators here at Maple University. You will not be paid or receive any other form of compensation as a direct result of your participation. Your answers will not affect your official status with the Maple University. If you are a current student, your decision to participate (or not) in the research will have no effect on your grades in any course/program that you may be enrolled in at the Maple University.

If you choose to be quoted and cited by your real name, the quotation may have a positive or negative impact on your reputation. Even if you are quoted anonymously, circumstantial details in your data may make you identifiable to readers who also played a role in the course or program you are speaking towards. Furthermore, due to the nature of focus group data collection, your anonymity may be compromised by the participation of other participants in the focus group session. Although the researcher will safeguard the confidentiality of the discussion to the best of his/her ability, the nature of focus groups prevents the researcher from guaranteeing that other members of the group will do so. Please respect the confidentiality of the other members of the group by not repeating what is said in the focus group to others, and be aware that other members of the group may not respect your confidentiality.

What Happens to the Information I Provide?

We will report research according to the anonymity conditions you have chosen below. It will be reported as appropriate within the university to evaluate courses and programs employing innovative pedagogical practices, and, plan for the support and development of similar programs. Data may also be included in ongoing research of these courses and programs. The research may be reported in scholarly journal articles, books and chapters, or presented at a scholarly conference. In addition, selected quotations (according to conditions below) may be used in Maple University websites, presentations, or public documents. Data will also be used in the doctoral thesis of the researcher which will be publicly available at the MapleU Library.

Data will be stored in locked filing cabinets in the offices of the researchers and in password-protected areas of their computers. Data will be stored indefinitely. The accumulated raw data of any interviews will only be accessible to the members of the research. The results will be reported only according to the conditions of anonymity and confidentiality that you select; this consent information will be kept with your data. If your information is not withdrawn, only the research team or Research Assistants who sign a confidentiality agreement will have access to the collected data.

Anonymity Conditions

There are several anonymity options for you to consider. You can choose all, some or none of them. Please put a check mark on the corresponding line(s) that grants your permission to:

I grant permission to be audio taped (focus group; for data verification only): *Yes: ___ No: ___*

I grant permission to be video-taped (focus group; for data verification only): *Yes: ___ No: ___*

I wish to remain anonymous, but you may refer to me by a pseudonym:* *Yes: ___ No: ___*

The pseudonym I choose for myself is: ____

You may quote me and use my name: *Yes: ___ No: ___*

*As noted above under "Are there risks or benefits," even if your data is kept anonymous, there is a possibility that your identity will be deduced by circumstantial details known by readers who are familiar with your activities as course names you provide commentary on may be reported.

*By choosing a pseudonym you will be quoted anonymously and referenced by said pseudonym in any reports

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Signatures (written consent)

Your signature on this form indicates that you 1) understand to your satisfaction the information provided to you about your participation in this research project, and 2) agree to participate as a research subject.

In no way does this waive your legal rights nor release the investigators, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from this research project at any time. You should feel free to ask for clarification or new information throughout your participation.

Participant's Name: (please print)

____

Participant's Signature ______________________________________Date:

____

Participants: Please also fill out the anonymity condition choices offered above.

Researcher's Name: (please print)

____

Researcher's Signature: _______________________________________Date: _______________

Questions/Concerns
If you have any further questions or want clarification regarding this research and/or your participation, please contact: K Lord, PhD Candidate, Maple University, klord@MapleU.ca OR Dr. C.B., Assistant Professor, Faculty of Education, Maple University, cb@MapleU.ca. Furthermore, if your participation in this research causes you undue stress or upset you can access the University Counselling Centre at 333-333-3333or the University Health Centre at 444-444-4444.

APPENDIX H: Recruitment Email for Students/Alumni

Dear Student and/or Alumni,

We kindly request your participation in research being conducted for completion of a doctoral thesis on a case study of a pilot program being introduced in the Faculty of Engineering and Applied Sciences at Maple University. This research aims to utilize curricular peer mentoring as a pedagogical intervention to address the multitude of internal constraints and stakeholder demands universities contend with at present. The goal of this ongoing research is to better understand, evaluate, and support the development of non-traditional educational methodology, specifically curricular peer mentoring, at the Maple Universityand to provide data and testimonials for the creation of a body of knowledge to further the integration of curricular pedagogy into the educational practices at the Maple University.

Providing a quality education is a fundamental objective of all academic institutions. Innovation in traditional instruction is an area that demands further study in order to draw comparisons across individual teaching practices to delineate similarities and determine valuable practices moving forward. You were invited to participate in this study because you have or may have in the past been a student in a course involving unique teaching methods and/or been recognized as being taught using a curricular peer mentoring approach.

This is your chance to have your voice heard! Your participation may impact our understanding of non-traditional instruction methods, improve our programs and courses, and provide material for further development of research in this area.

The attached consent form contains further information about our research methods.

If you are willing to participate:
Please email us a copy of the attached consent form that lets us know your desired forms of participation and your anonymity conditions. There are a variety of options (you can choose any or all):

- a survey,
- a 10-20 minute interview,
- donate a testimonial, a letter of support and/or any other relevant documents you have written, such as course assignments undertaken in classrooms employing innovative pedagogical practices

We have attached a survey [*or, here is the link to an online survey*] in case you would like to participate in that manner.

If you are willing to be interviewed or submit course materials/testimonials we will need your signature on the consent form. You can sign it at the time of the interview.

Please reply by________.

If you have any questions, comments, or concerns please contact: K Lord, PhD Candidate, Maple University, klord@MapleU.ca OR Dr. C.B., Assistant Professor, Faculty of Education, Maple University, cb@MapleU.ca.

Thank you, K Lord.

The proposal for this research has been reviewed by the Interdisciplinary Committee on Ethics in Human Research and found to be in compliance with Maple University's ethics policy. If you have ethical concerns about the research, such as the way you have been treated or your rights as a participant, you may contact the Chairperson of the ICEHR at icehr@MapleU.ca or by telephone at 111-111-1111.

APPENDIX I: Recruitment Email for Faculty/Staff

Dear Educator,

We kindly request your participation in research on innovative pedagogy at the Maple University in support of Vanier funded doctoral research. The goal of this ongoing research is to better understand, evaluate, and support the development of non-traditional educational methodology, specifically curricular peer mentoring, at the Maple University and to provide data and testimonials for the creation of a body of knowledge to further the integration of curricular pedagogy into the educational practices at the Maple University.

You are invited to participate in this study because you have or may have in the past taught a course involving curricular peer mentoring, and/or been a colleague of someone who has taught using this approach. Providing a quality education is a fundamental objective of all academic institutions. How an institution accomplishes this is dependent on the individual educators it employs and their conception of what it means to educate, and the manner in which they organize their classrooms to do so. Innovation in traditional instruction is an area that demands further study in order to draw comparisons across individual teaching practices to delineate similarities and determine valuable practices moving forward.

This is your chance to have your voice heard and to give your students and fellow educators a voice in innovative pedagogical development at our institution. Your participation may impact our understanding of non-traditional instruction methods, improve our programs and courses, and provide material for further development of research in this area.

The attached consent form contains further information about our research methods.

1) **Please help us recruit your students.**

We rely on instructors like you to

- Forward a recruitment package to your present and former students/alumni so that they can participate in research and contribute to the study. Please note that when forwarding the recruitment package do not add anything beyond a brief message indicating that the invitation to participate is being delivered on behalf of the research team.
- Provide us with the names and public contact information of any of your colleagues who may be willing to participate in our research

Attached is an email template and attachments that you can forward to students.

2) **If you are willing to participate as a research subject:**

There are a variety of ways you can participate (you can choose any or all):

- Complete a survey about your teaching experiences,
- Participate in a 10-20 minute interview,
- Donate some of your course assignment descriptions and course outlines and instructional material for analysis.

We have attached a survey [*or, here is the link to an online survey*] in case you would like to participate in that manner.

If you are willing to be interviewed or submit course materials/testimonials we will need your signature on the consent form. You can sign it at the time of the interview.

If you are willing to provide course materials, please provide them in electronic format and email them to this email address.

Please reply by________.

If you have any questions, comments, or concerns please contact: K Lord, PhD Candidate, Maple University, klord@MapleU.ca OR Dr. C.B., Assistant Professor, Faculty of Education, Maple University, cb@MapleU.ca.

Thank you,

K Lord

The proposal for this research has been reviewed by the Interdisciplinary Committee on Ethics in Human Research and found to be in compliance with Maple University's ethics policy. If you have ethical concerns about the research, such as the way you have been treated or your rights as a participant, you may contact the Chairperson of the ICEHR at icehr@MapleU.ca or by telephone at 111-111-1111.

APPENDIX J: Recruitment Email for Deans/Department Heads

Dear Dean/Department Head,

We kindly request your participation in research on innovative pedagogy at the Maple Universityin support of Vanier funded doctoral research. The goal of this ongoing research is to better understand, evaluate, and support the development of non-traditional educational methodology, specifically curricular peer mentoring, at the Maple Universityand to provide data and testimonials for the creation of a body of knowledge to further the integration of curricular pedagogy into the educational practices at the Maple University.

You and your unit's participation are invited to contribute to this research project and can choose to do so in the following ways:

1) By helping recruit potential faculty members for the study who employ non-traditional teaching methods or focus on the self-actualization of the learner within their classrooms. You can make them aware of this research project by forwarding the attached recruitment notice and consent form to faculty and staff within your unit as appropriate.

2) By participating in the research itself through the provision of feedback and commentary on any of the specific innovative pedagogical practices employed by your faculty members and to offer your opinions generally on innovative pedagogy, and in particular curricular peer mentoring.

If you are willing to be interviewed or submit course materials/testimonials we will need your signature on the consent form. You can sign it at the time of the interview.

If you have any questions, comments, or concerns please contact: K Lord, PhD Candidate, Maple University, klord@MapleU.ca OR Dr. C.B., Assistant Professor, Faculty of Education, Maple University, cb@MapleU.ca.

Thank you,

K Lord

The proposal for this research has been reviewed by the Interdisciplinary Committee on Ethics in Human Research and found to be in compliance with Maple University's ethics policy. If you have ethical concerns about the research, such as the way you have been treated or your rights as a participant, you may contact the Chairperson of the ICEHR at icehr@MapleU.ca or by telephone at 111-111-1111.

APPENDIX K: Student Survey

Curricular Peer Mentoring Pilot Program -- Student Survey –

We ask for your feedback to assess and understand the dynamics of peer mentoring in your course this term. Your responses help us understand how students engage with peer mentors and how undergraduate education is impacted by the program. Surveys will be collected by the researchers. **Your peer mentor(s) and Instructor(s) will have NO access to the handwritten surveys and will receive only an anonymous summary of survey results**. Researcher **Kristina (Kat) Lord** will be the only one who has access to the raw data and any identifying information you may provide. Your instructor will not gain access to any raw data. Surveys will be stored for an indefinite period in password-protected folders and locked filing cabinets in the researcher's office. Data may also be stored in a password-protected online survey application such as SurveyMonkey whose servers are located in the United States and which are therefore subject to the US Patriot Act. Anonymous survey results may be reported on websites, academic research reports and presentations, within the institution, and for awards and funding purposes. **Your participation is entirely voluntary** and you may skip any questions or decide not to submit this survey. Filling out and submitting the survey demonstrates your informed consent to participate. If you have any questions or concerns about this survey, contact Kristina (Kat) Lord at klord@MapleU.ca or the Chairperson of the ICEHR at icehr@MapleU.ca or by telephone at 111-111-1111.

COURSE NAME (i.e. ENGI 0000) ________________ **Instructor's Name** ______________________

You identify your gender as: ____Your Age: ______

Your major program of study ________________ Year of Program (including transfer credit) _________

Your estimated current GPA: _______ Letter grade you expect to earn in this course: (A, B-, C) _______

How many university courses were you taking this term, including this one? _____

How much time do you commit to: **Employment** ___ hrs/week; **Volunteer** activity ___ hrs/week; **Caregiving** ___ hrs/week

On average, did you spend more, less, or equal time studying or preparing for this course than most other courses you have taken in your program? **Less** time ___ **Equal** time ___ **More** time ___ (**Approx. hrs/week** for this course**:** ____)

Peer mentoring DURING class:

___ The instructor/TA explained the peer mentor(s)'s roles near the beginning of term

___ I heard the peer mentor(s)'s introduction in class

___ I observed the peer mentor(s) participate actively in the classroom setting ___ times

___ I heard the peer mentor(s) announce an activity or availability ___ times

___ I heard the peer mentor(s) give one or more presentations in class ___ times

My active interaction DURING class time, if any:

___ I participated when the peer mentor(s) facilitated (or co-facilitated) a small-group or large-group discussion or activity in class ___ times

___ I talked with the peer mentor(s) in the classroom or hallway during a break, or before or after the class began ___ times

Receiving peer mentoring OUTSIDE of class:

___ I received a peer mentor's email or online message sent to the whole tutorial/class approximately ___ times

___ I received a personal email message from a peer mentor
approximately ___ times

___ I received a peer mentor's written feedback on my draft, assignment or performance approximately ___ times

My active interaction OUTSIDE of class time, if any

___ I replied to a peer mentor's email or online message approx. ___ times

___ I asked the peer mentor(s) a simple, quick question via email approximately ___ times

___ I asked the peer mentor(s) for advice or feedback via email approximately ___ times

___ I participated in an activity offered by the peer mentor outside of class time ___ times

___ I met the peer mentor during their announced hours or I made an appointment with the peer mentor ___ times

OTHER peer mentoring interaction not listed above:

1. Was your peer mentor(s) **accessible enough** at the following times/places?

During class:	☐ **Yes**	☐ **No**	☐ **N/A**
Outside of class time:			
Group activities	☐ **Yes**	☐ **No**	☐ **N/A**
One-on-one Mentoring:	☐ **Yes**	☐ **No**	☐ **N/A**
Email, online, or social media:	☐ **Yes**	☐ **No**	☐ **N/A**

2. IF you did NOT interact actively with the peer mentor(s) OUTSIDE of class time, what were the reasons?

3. Approximately how many hours (total) have you spent ACTIVELY interacting with the peer mentor(s)? _____ hrs

4. How did peer mentoring affect the social and emotional aspects of learning in this course?

a) Making the course more student-friendly, welcoming

☐ Significant BENEFIT	☐ Moderate BENEFIT	☐ No difference	☐ Moderately NEGATIVE effect Moderate BENEFIT	☐ Significantly NEGATIVE effect	☐ I don't know

b) Making the learning experience more interesting or enjoyable

☐ Significant BENEFIT	☐ Moderate BENEFIT	☐ No difference	☐ Moderately NEGATIVE effect Moderate BENEFIT	☐ Significantly NEGATIVE effect	☐ I don't know

c) Supporting my positive morale and self-confidence as a learner

☐ Significant BENEFIT	☐ Moderate BENEFIT	☐ No difference	☐ Moderately NEGATIVE effect Moderate BENEFIT	☐ Significantly NEGATIVE effect	☐ I don't know

d) Supporting my active participation in learning within class or outside of class

☐ Significant BENEFIT	☐ Moderate BENEFIT	☐ No difference	☐ Moderately NEGATIVE effect Moderate BENEFIT	☐ Significantly NEGATIVE effect	☐ I don't know

Please describe how or why peer mentoring had the above effects, if any, on the social/emotional aspects of learning:

5. To what degree did peer mentoring activities enhance your academic learning in the course?
a) My understanding of the course's teaching and learning methods (i.e. instructor expectations, lab/assignment instructions, time management, study approaches, teamwork, course technologies, accessing course resources)

☐ Significant BENEFIT	☐ Moderate BENEFIT	☐ No difference	☐ Moderately NEGATIVE effect Moderate BENEFIT	☐ Significantly NEGATIVE effect	☐ I don't know

b) My understanding of the subject matter (i.e. understanding texts, lectures, the content of exams and assignments)

☐ Significant BENEFIT	☐ Moderate BENEFIT	☐ No difference	☐ Moderately NEGATIVE effect Moderate BENEFIT	☐ Significantly NEGATIVE effect	☐ I don't know

My academic skills related to the course (i.e. critical thinking, analysis, research, writing, oral presentations)

☐ Significant BENEFIT	☐ Moderate BENEFIT	☐ No difference	☐ Moderately NEGATIVE effect Moderate BENEFIT	☐ Significantly NEGATIVE effect	☐ I don't know

Please describe how or why peer mentoring had the above effects, if any, on your academic learning:

Your feedback to the undergraduate peer mentor(s) and teaching staff:

6. What peer mentoring activities or roles were **most beneficial** to your learning experience this term?

7. Your messages of **advice, constructive criticism, or encouragement** to your peer mentor(s) (Name each mentor if you had two or more in this class)

8. What could the **instructor(s) and/or TA** do to make peer mentoring more effective in this course?

The Peer Mentoring Program in general:

9. Had you heard of the peer mentoring program prior to taking this class? ___ yes ___ no

10. Have you taken (or are you currently taking) any other courses that have had an undergraduate peer mentor in them?
 ___ yes ___ no If yes, which courses?

11. Overall, how has the Peer Mentoring Program affected your MAPLEU learning experience so far? Choose one:

☐	Significant BENEFIT	☐	Moderate BENEFIT	☐	No difference	☐	Moderately NEGATIVE effect Moderate BENEFIT	☐	Significantly NEGATIVE effect	☐	I don't know

12. Would knowing in advance there is a peer mentor assigned to a specific course's section, lab or tutorial motivate you to enroll in that section, lab or tutorial, rather than another one without a peer mentor?

13. Would you recommend to your peers taking a class where learning is facilitated by a peer mentor? ___ yes __No

14. Are there any OTHER courses you've taken that would benefit by having a peer mentor? If so, please list.

OPTIONAL: Supporting further peer mentoring research

a. Are you willing to allow us to **access your academic records** at the MAPLEU ? ___ yes ___ no
 (i.e. to help us study the potential impact on a larger student population's academic progress and graduation rates)

b. Are you willing to allow us to **recruit you for future survey(s) or interview(s)?** ___ yes ___no
 (i.e. to help us understand any long-term individual impacts)

 If you chose "yes" to option a or b above, please provide your **MAPLEU ID number and email address**:
 ____

Thank you for your participation!

APPENDIX L: Faculty/Staff/Administration Survey

Curricular Peer Mentoring Pilot Program – Faculty/Staff Survey –

We ask for your feedback to assess and understand your knowledge about and/or opinion about the curricular peer mentoring pilot program in the Faculty of Engineering and Applied Sciences at Maple University. Your responses help us understand how faculty and staff engage with non-traditional pedagogical education methodology and how engineering undergraduate education is understood by faculty and staff in this discipline and professional field. Surveys will be collected by the researchers. Researcher **Kristina (Kat) Lord** will be the only one who has access to the raw data and any identifying information you may provide. Your colleagues or superiors will not gain access to any raw data. Surveys will be stored for an indefinite period in password-protected folders and locked filing cabinets in the researcher's office. Data may also be stored in a password-protected online survey application such as SurveyMonkey whose servers are located in the United States and which are therefore subject to the US Patriot Act. Anonymous survey results may be reported on websites, academic research reports and presentations, within the institution, and for awards and funding purposes. **Your participation is entirely voluntary** and you may skip any questions or decide not to submit this survey. Filling out and submitting the survey demonstrates your informed consent to participate. If you have any questions or concerns about this survey, contact Kristina (Kat) Lord at klord@MapleU.ca or the Chairperson of the ICEHR at icehr@MapleU.ca or by telephone at 111-111-1111.

You identify your gender as: ____Your Age: ______________ Academic/Staff position:____ Courses taught: ____ Your major area of concentration: _____________________________________ Years spent teaching: ____________ How many university courses were you teaching this term? ____ How much time (hrs/week) do you commit to: **Employment** ___; **Volunteer** activity ___; **Caregiving** ___ On average, how much time do you spend teaching or preparing for your courses? **Approx. hrs/week** this course**:** ___
I am aware of the curricular peer mentoring pilot program: **___Yes** **___No**

<table>
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If you answered ‘Yes’ please answer the following questions:

1. Are there any courses that you know of that have had an undergraduate peer mentor in them?
 ___ yes ___ no If yes, which courses?

2. Overall, how do you think the Peer Mentoring Program has affected the MAPLEU Engineering learning experience so far?
Rate on a scale of 1 to 5, 1 being ‘little affect’, 5 being ‘great effect’.

3. Would knowing in advance there is a peer mentor available to be assigned to a specific course's section, lab or tutorial motivate you to teach that section, lab or tutorial using a peer mentor?

4. Would you recommend hosting a peer mentor to your colleagues ___ yes ___ no

5. Are there any courses in the department that you think would benefit by having a peer mentor? If so, please list them: ____________.

</td>
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If you answered ‘No’ please answer the following questions:

1. Are there courses that you know of that use non-traditional teaching methods (i.e. not exclusively lecture-based) in the Faculty of Engineering and Applied Sciences?
___ yes ___ no If yes, which courses?

2. How useful do you think a lecture only format is for teaching engineering curriculum?
Rate on a scale of 1 to 5, 1 being ‘not effective’, 5 being ‘very effective’.

3. How useful do you think a non-traditional approach is for teaching engineering curriculum?
Rate on a scale of 1 to 5, 1 being ‘not effective’, 5 being ‘very effective’.

4. Would you recommend utilizing non-traditional teaching methods to your colleagues ___ yes ___ no

5. Are there any courses in the department that you think would benefit from a non-traditional approach? If so, please list them: _______________________.

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OTHER knowledge of peer mentoring not listed above:

</td>
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</table>

Did YOU host a peer mentor in your course this term:
___ yes ___ no If yes, which course?

**Faculty members that answer ‘NO’ can skip the following set of questions if completing a print copy of the survey, otherwise they will be automatically redirected to the ‘SUBMIT’ page.*

Questions for Faculty that answer ‘YES’:

15. Was your peer mentor(s) **available** enough at the following times/places?

During class:	☐ **Yes**	☐ **No**	☐ **N/A**
Outside of class time:			
Group activities	☐ **Yes**	☐ **No**	☐ **N/A**

One-on-one Mentoring:	☐ **Yes**	☐ **No**	☐ **N/A**
Email, online, or social media:	☐ **Yes**	☐ **No**	☐ **N/A**

16. Did you interact actively with the peer mentor(s) OUTSIDE of class time to plan for their participation in your course?

17. Approximately how many hours (total) have you spent ACTIVELY spent planning and interacting with the peer mentor(s)? ______ hrs

18. How did peer mentoring affect the social and emotional aspects of learning for the students in your course?

a) Making the course more student-friendly, welcoming

☐ Significantly NEGATIVE effect ☐ Moderately NEGATIVE effect ☐ No difference ☐ Moderate BENEFIT ☐ Significant BENEFIT ☐ I don't know

b) Making the learning experience more interesting or enjoyable

☐ Significantly NEGATIVE effect ☐ Moderately NEGATIVE effect ☐ No difference ☐ Moderate BENEFIT ☐ Significant BENEFIT ☐ I don't know

c) Instilling a positive morale and self-confidence in the students

☐ Significantly NEGATIVE effect ☐ Moderately NEGATIVE effect ☐ No difference ☐ Moderate BENEFIT ☐ Significant BENEFIT ☐ I don't know

d) Supporting active participation in learning within class or outside of class

☐ Significantly NEGATIVE effect ☐ Moderately NEGATIVE effect ☐ No difference ☐ Moderate BENEFIT ☐ Significant BENEFIT ☐ I don't know

Please describe how or why peer mentoring had the above effects, if any, on the social/emotional aspects of learning:

19. To what degree did peer mentoring activities enhance the academic learning in your course?

a) Student understanding of the course's teaching and learning methods (i.e. instructor expectations, lab/assignment instructions, time management, study approaches, teamwork, course technologies, accessing course resources)

☐ Significantly NEGATIVE effect	☐ Moderately NEGATIVE effect	☐ No differen ce	☐ Moderate BENEFIT	☐ Significant BENEFIT	☐ I don' t kno w

b) Student understanding of the subject matter (i.e. understanding texts, lectures, the content of exams and assignments)

☐ Significantly NEGATIVE effect	☐ Moderately NEGATIVE effect	☐ No differen ce	☐ Moderate BENEFIT	☐ Significant BENEFIT	☐ I don' t kno w

Student academic skills related to the course (i.e. critical thinking, analysis, research, writing, oral presentations)

☐ Significantly NEGATIVE effect	☐ Moderately NEGATIVE effect	☐ No differen ce	☐ Moderate BENEFIT	☐ Significant BENEFIT	☐ I don' t kno w

Please describe how or why peer mentoring had the above effects, if any, on the academic learning of students in your course:

OPTIONAL: Supporting further peer mentoring research

Are you willing to allow us to **recruit you for future survey(s) or interview(s)?** ___ yes ___no
(i.e. to help us understand any long-term individual impacts)

If you chose "yes" to option a or b above, please provide your **MAPLEU ID number and email address**: _________________

Thank you for your participation!

APPENDIX M: Student Interview Questions

Curricular Peer Mentoring Pilot Program -- Student Interview –

We ask for your feedback to assess and understand the dynamics of peer mentoring in your course this term. Your responses help us understand how students engage with peer mentors and how undergraduate education is impacted by the program. Interviews will be collected by the researcher. **Your peer mentor(s) and Instructor(s) will have NO access to the interview data and will receive only an anonymous summary of interview results**. Researcher **Kristina (Kat) Lord** will be the only one who has access to the raw data and any identifying information you may provide. Your instructor will not gain access to any raw data. Interview data will be stored for an indefinite period in password-protected folders and locked filing cabinets in the researcher's office. Anonymous interview results may be reported on websites, academic research reports and presentations, within the institution, and for awards and funding purposes. **Your participation is entirely voluntary** and you may skip any questions or decide not to participate in the interview process at any point. Signing the attached consent form demonstrates your informed consent to participate. If you have any questions or concerns about this interview process, contact Kristina (Kat) Lord at klord@MapleU.ca or the Chairperson of the ICEHR at icehr@MapleU.ca or by telephone at 111-111-1111.

COURSE NAME (i.e. ENGI 0000) _________________ Instructor's Name ______________________
You identify your gender as: ____Your Age: ______
Your major program of study ________________ Year of Program (including transfer credit) _________
Your estimated current GPA: _______ Letter grade you expect to earn in this course: (A, B-, C) _______
How many university courses were you taking this term, including this one? _____
How much time do you commit to: **Employment** ___ hrs/week; **Volunteer** activity ___ hrs/week; **Caregiving** ___ hrs/week
On average, did you spend more, less, or equal time studying or preparing for this course than most other courses you have taken in your program? **Less** time ___ **Equal** time ___ **More** time ___ (**Approx. hrs/week** for this course**:** ____)

1. Was your peer mentor(s) accessible enough?
2. If you did NOT interact actively with the peer mentor(s) OUTSIDE of class time, what were the reasons?
3. Approximately how many hours (total) have you spent ACTIVELY interacting with the peer mentor(s)?
4. How did peer mentoring affect the social and emotional aspects of learning in this course?
5. To what degree did peer mentoring activities enhance your academic learning in the course?
6. What peer mentoring activities or roles were most beneficial to your learning experience this term?
7. Do you have any messages of advice, constructive criticism, or encouragement for your peer mentor(s)?
8. What could the instructor(s) and/or TA do to make peer mentoring more effective in this course?
9. Had you heard of the peer mentoring program prior to taking this class?
10. What was your impression of the peer mentoring program before this class?

11. Overall, how has the peer mentoring program affected your MAPLEU learning experience so far?

12. Would knowing in advance there is a peer mentor assigned to a specific course's section, lab or tutorial motivate you to enroll in that section, lab or tutorial, rather than another one without a peer mentor?

13. Would you recommend to your peers taking a class where learning is facilitated by a peer mentor? Why or why not?

14. Are there any other courses you've taken that would benefit by having a peer mentor? Explain.

15. Do you identify yourself as a minority in the MAPLEU Faculty of Engineering and Applied Sciences, either in terms of gender, sexual orientation, race or ethnicity? Explain:

16. Has being in a class with a peer mentor present affected your experience as a self-identified student in a minority population?

APPENDIX N: Faculty/Staff/Administration Interview Questions

Curricular Peer Mentoring Pilot Program – Faculty/Staff/Administrator Interview –

We ask for your feedback to assess and understand your knowledge about and/or opinion about the curricular peer mentoring pilot program in the Faculty of Engineering and Applied Sciences at Maple University. Your responses help us understand how faculty and staff engage with non-traditional pedagogical education methodology and how engineering undergraduate education is understood by faculty and staff in this discipline and professional field. Surveys will be collected by the researchers. Researcher **Kristina (Kat) Lord** will be the only one who has access to the raw data and any identifying information you may provide. Your colleagues or superiors will not gain access to any raw data. Interview data will be stored for an indefinite period in password-protected folders and locked filing cabinets in the researcher's office. Anonymous interview results may be reported on websites, academic research reports and presentations, within the institution, and for awards and funding purposes. **Your participation is entirely voluntary** and you may skip any questions or decide not to participate in the interview process at any point. Signing the attached consent form demonstrates your informed consent to participate. If you have any questions or concerns about this interview process, contact Kristina (Kat) Lord at klord@MapleU.ca or the Chairperson of the ICEHR at icehr@MapleU.ca or by telephone at 111-111-1111.

You identify your gender as: ____Your Age: ________________

Academic/Staff position:____

Courses taught: ____

Your major area of concentration: _____________________________________ Years spent teaching: ____________

How many university courses were you teaching this term? ____How much time do you commit to: **Employment** ___ hrs/week; **Volunteer** activity ___ hrs/week; **Caregiving** ___ hrs/week

On average, how much time do you spend teaching or preparing for your courses? **Approx. hrs/week** for this course**:** ____

17. Overall, how do you think the Peer Mentoring Program has affected the MAPLEU Engineering learning experience so far?

18. Would knowing in advance there is a peer mentor available to be assigned to a specific course's section, lab or tutorial motivate you to teach that section, lab or tutorial using a peer mentor?

19. Would you recommend hosting a peer mentor to your colleagues? Please explain:

20. Are there any courses in the department that you think would benefit by having a peer mentor? If so, please explain:

21. Was your peer mentor(s) available enough throughout the course? Please explain:

22. Did you interact actively with the peer mentor(s) OUTSIDE of class time to plan for their participation in your course?

23. Approximately how many hours (total) have you spent ACTIVELY spent planning and interacting with the peer mentor(s)? ______ hrs

24. How did peer mentoring affect the social and emotional aspects of learning for the students in your course?

25. To what degree did peer mentoring activities enhance the academic learning in your course?

26. What peer mentoring activities or roles were most beneficial to the learning experience this term?

27. What could you as the instructor do, if anything, to make peer mentoring more effective in your course?

28. Do you think peer mentoring is a useful pedagogical tool for university engineering undergraduate education? Why or why not?

APPENDIX O: Student Focus Group Questions

Curricular Peer Mentoring Pilot Program – Focus Group –

We ask for your feedback to assess and understand the dynamics of peer mentoring in your course this term by participating in a focus group, which is a 'group interview' process wherein you and your peers will be asked a series of questions about your experience with peer mentoring. Your responses help us understand how students engage with peer mentors and how undergraduate education is impacted by the program. Focus groups will be conducted by the researcher. **Your peer mentor(s) and Instructor(s) will have NO access to the focus group data and will receive only an anonymous summary of results**. Researcher **Kristina (Kat) Lord** will be the only one who has access to the raw data and any identifying information you may provide. Your instructor will not gain access to any raw data. Data will be stored for an indefinite period in password-protected folders and locked filing cabinets in the researcher's office. Anonymous results may be reported on websites, academic research reports and presentations, within the institution, and for awards and funding purposes. **Your participation is entirely voluntary** and you may skip any questions or decide not to participate in the focus group at any point. Signing the attached consent form demonstrates your informed consent to participate. If you have any questions or concerns about this process, contact Kristina (Kat) Lord at klord@MapleU.ca or the Chairperson of the ICEHR at icehr@MapleU.ca or by telephone at 111-111-1111.

COURSE NAME (i.e. ENGI 0000) _________________ Instructor's Name ______________________
You identify your gender as: ____Your Age: ______
Your major program of study ________________ Year of Program (including transfer credit) _________
Your estimated current GPA: _______ Letter grade you expect to earn in this course: (A, B-, C) _______
How many university courses were you taking this term, including this one? _____
How much time do you commit to: **Employment** ___ hrs/week; **Volunteer** activity ___ hrs/week; **Caregiving** ___ hrs/week
On average, did you spend more, less, or equal time studying or preparing for this course than most other courses you have taken in your program? **Less** time ___ **Equal** time ___ **More** time ___ (**Approx. hrs/week** for this course**:** ____)

29. Was your peer mentor(s) accessible enough?

30. If you did NOT interact actively with the peer mentor(s) OUTSIDE of class time, what were the reasons?

31. Approximately how many hours (total) have you spent ACTIVELY interacting with the peer mentor(s)?

32. How did peer mentoring affect the social and emotional aspects of learning in this course?

33. To what degree did peer mentoring activities enhance your academic learning in the course?

34. What peer mentoring activities or roles were most beneficial to your learning experience this term?

35. Do you have any messages of advice, constructive criticism, or encouragement for your peer mentor(s)?

36. What could the instructor(s) and/or TA do to make peer mentoring more effective in this course?

37. Had you heard of the peer mentoring program prior to taking this class?

38. What was your impression of the peer mentoring program before this class?

39. Overall, how has the peer mentoring program affected your MAPLEU learning experience so far?

40. Would knowing in advance there is a peer mentor assigned to a specific course's section, lab or tutorial motivate you to enroll in that section, lab or tutorial, rather than another one without a peer mentor?

41. Would you recommend to your peers taking a class where learning is facilitated by a peer mentor? Why or why not?

42. Are there any other courses you've taken that would benefit by having a peer mentor? Explain.

43. Do you identify yourself as a minority in the MAPLEU Faculty of Engineering and Applied Sciences, either in terms of gender, sexual orientation, race or ethnicity? Explain:

44. Has being in a class with a peer mentor present affected your experience as a self-identified student in a minority population?

APPENDIX P: Print & Digital Recruitment Advert/Poster – Written Text Only

Tell us what ***you*** think about the CURRICULAR PEER MENTORING PILOT PROGRAM that took place in the FACULTY OF ENGINEERING AND APPLIED SCIENCES in

This is your chance to have your voice heard! Your participation may improve engineering programs and courses, impact our understanding of non-traditional instruction methods, and innovate engineering education!

Contact K LORD at klord@MapleU.ca or 222-222-2222 to IMPACT YOUR ENGINEERING EXPERIENCE!

APPENDIX Q: Alternative Teaching Methods

Student-Centered Teaching Methods

(adapted by C. Sealfon from Table 2 of the PCAST report)

Types of active learning with feedback	Description	Examples of studies that demonstrate enhanced learning
Small group discussion and peer instruction (also called "Think-Pair-Share" or "ConcepTests") (example)	Students think about the answer to a question posed by the instructor, and then discuss the question among each other. The instructor selects students to explain the consensus to the class.	Anderson et al. (2005); Armbruster et al. (2009); Armstrong et al. (2007); Beichner et al. (1999); Born et al. (2002); Crouch and Mazur (2001); Fagen (2002); Lasry et al. (2008); Lewis and Lewis (2005); McDaniel (2007a, 2007b); Rivard and Straw (2000); Tessier (2004 and 2007); Tien et al. (2002)
Effective use of clickers (examples/videos)	Hand-held electronic devices can allow students to anonymously vote on answers to multiple-choice questions in real time. Clickers are usually most effective when used with peer instruction.	Smith et al. (2009, 2011)
One-minute papers (example)	Given an open-ended question, students spend one minute writing their answers on index cards, which are collected by the instructor. Often given at the end of class, the questions ask students what was the most important concept they learned or what remains unclear.	Almer et al. (1998); Chizmar and Ostrosky (1998); Rivard and Straw (2000)
Interactive lecture demonstrations (ILDs) (example)	Students make predictions about the outcome of a classroom demonstration. They then observe the experiment or demonstration, describe the results, and discuss and reflect on the observed outcome.	Crouch et al. (2004); Sharma et al. (2010)
Case studies (examples)	Students draw inferences and make decisions given a detailed description of a scenario (often based on a true story).	Preszler (2009)
Concept mapping (example)	Students create a visual representation (similar to a flow chart) that identifies and shows the interconnections among various ideas related to a specific topic or problem.	Foncesca et al. (2004); Prezler (2004); Yarden et al. (2004)
Tutorial worksheets (example)	Students work through guided-discovery worksheets that lead them through a chain of logic to solve a problem or overcome a conceptual difficulty. Students complete the exercises in small groups, while the instructor circulates among the groups to ask targeted questions or to facilitate discussion (as needed or at specific "check points" in the worksheet).	Ambrose (2004); Finkelstein and Pollock (2005); McDermott et al. (1994); Prather et al. (2004)

APPENDIX R: Course Syllabus (title redacted for anonymity)

ENGINEERING XXXX

Communication: *Please note that the instructor will be available outside the stated office hours by appointment, or over email. You can expect a response within 24 hours.*

COURSE DESCRIPTION:

This course teaches you how to become an effective leader by practicing peer leadership within a real-life context. Admission to this course is competitive, and only available to senior level engineering students who have demonstrated academic excellence throughout their undergraduate studies. The course will provide background useful in both the classroom and in the professional workplace, and will also enhance students' learning of their own field of study through their interaction with other students.

Students admitted into the course will receive practical experience by participating in a 40 hour practicum that places them back in junior level courses. Students select which instructors they want to work with, and in which classes they would like to serve their practicum hours. They act as leaders to their peers by mentoring them on the academic work within the course. Their mentorship practice can take many forms, but is primarily classroom-based and focused on course content. Activities may include facilitating class discussion, troubleshooting assignments, organizing and assisting study groups, or coaching peers in their test-taking, writing, and presentation skills.

Alongside their practicum, students will participate in a seminar course to examine what it means to learn, teach, and lead. They will critically examine the acts of learning, teaching, and leading to understand how they are related, and how they effect and are affected by each other. These practices are examined in the context of the larger global realities and complexities that engineers may need to understand and respond to within their continuing education and future profession, seeking to draw connections between these realities and the classroom.

The course is therefore structured around four main themes:
(1) Learning,
(2) Teaching,
(3) Leading,
(4) Complex Realities.

PREREQUISTIES:	Submission of a Course Application
COREQUISITES:	Enrollment in Year 3 or Year 4 of an undergraduate engineering degree
CREDIT VALUE:	3 credits

RESOURCES:

TEXT BOOK

1. Smith, L.C. (2011). *The World in 2050: Four Forces Shaping Civilization's Northern Future.* New York, NY: Penguin Group.

2. Smith, T. (2009). *Curricular Peer Mentoring: A Handbook for Peer Mentors In Undergraduate Courses.* Victoria, BC: Trafford Publishing.

REFERENCES

Please note that supplemental readings and additional learning materials will be distributed throughout the semester via the online class hub and/or in class. Any supplemental readings will not require purchase.

MAJOR TOPICS:

- Introduction & orientation to peer mentoring
- Peer mentoring & higher learning theory
- Critical reflection
- Problem-based Learning
- Active learning
- Power & Leadership
- Effective leadership
- Sex & Sexism
- Difference & Discrimination
- Ethics & Pragmatism

***PLEASE NOTE:** Throughout the course there will be an ongoing discussion of global challenges and possible engineering responses as inspired by the course text *The World in 2050: Four Forces Shaping Civilization's Northern Future*

LEARNING OUTCOMES:

Upon successful completion of this course, the student will be able to:

1. Lead their peers through engineering activities
2. Mentor their peers on solving engineering problems
3. Facilitate the learning of their peers as they encounter engineering curriculum
4. Analyze and apply theories of learning, teaching, and leading within an academic context
5. Evaluate the effects of mentorship and leadership for use in their future professional practice
6. Integrate their learning within the seminar course and service-learning practicum to formulate nuanced understandings of real-world engineering challenges.

Graduate attributes include:

1. **Investigation:** An ability to conduct investigations of complex problems by methods that include appropriate experiments, analysis and interpretation of data, and synthesis of information in order to reach valid conclusions.

2. **Individual and team work:** An ability to work effectively as a member and leader in teams, preferably in a multi-disciplinary setting.

3. **Communication skills:** An ability to communicate complex engineering concepts within the profession and with society at large. Such ability includes reading, writing, speaking and listening, and the ability to comprehend and write effective reports and design documentation, and to give and effectively respond to clear instructions.

4. **Professionalism:** An understanding of the roles and responsibilities of the professional engineer in society, especially the primary role of protection of the public and the public interest.

5. **Impact of engineering on society and the environment:** An ability to analyze social and environmental aspects of engineering activities. Such ability includes an understanding of the interactions that engineering has with the economic, social, health, safety, legal, and cultural aspects of society, the uncertainties in the prediction of such interactions; and the concepts of sustainable design and development and environmental stewardship.

6. **Ethics and equity:** An ability to apply professional ethics, accountability, and equity.

7. **Life-long learning:** An ability to identify and to address their own educational needs in a changing world in ways sufficient to maintain their competence and to allow them to contribute to the advancement of knowledge.

Teaching and Learning Approach & Profile of a Successful Student

This course will teach engineering students about horizontal as opposed to vertical thought-processes, by asking students to consider different methods to debate and construct an argument and applying that to engineering specific problems. It will be a seminar-based course, with a large emphasis placed on interactivity, discussion, and debate. Alongside the seminar course is a service-learning component that asks students to apply the learning they do in the seminar to their in-class practicum hours in their host course with their host instructor.

A successful student will be someone who regularly attends class, comes to class prepared to engage in discussions with their classmates, and is open to new approaches to analyzing and solving complex problems. They will also consistently engage in the practicum component of the course. They will be assessed in both areas, but will be given clear instructions and continuous support throughout the course to help them be successful in all assessment metrics.

ASSESSMENT:

Assignment Summary	Each	Total
Semester Plan		**5%**
Seminar Lead		**10%**
Critical Reflections		**30%**
1	*10%*	
2	*10%*	
3	*10%*	
Leadership Philosophy		**15%**
Practicum Portfolio		**35%**
Intake I (instructor-student discussion)	*5%*	
Intake II (full portfolio)	*30%*	
Classroom contribution		**5%**
COURSE TOTAL		**100%**

Semester Plan (5%)

Students will be asked to organize a plan for the semester in collaboration with their host instructor that details how they will coordinate their practicum hours.

Seminar Lead (10%)

Students will be asked to lead one of the seminar classes throughout the term. They will be expected to have read the readings and present a short synopsis of them for their classmates. They will then facilitate class discussion for the remainder of the seminar.

Critical Reflections (30%)

Students will write a total of 3 reflections. These reflections will provide students an opportunity to critically analyze the course material in relation to their ongoing in-class practicum experience:

Leadership Philosophy (15%)

Students are required to develop a personal philosophy of leadership that reflects their understanding of the course content, and the learning they have taken away from the practicum experience. Students will present their leadership philosophy at term end.

Practicum Portfolio (35%)
[There will be two portfolio intakes: at mid-term and on the last day of class. The mid-term intake will be a discussion with the student about their progress-to-date with their portfolio and in the course.]

Students will be asked to synthesize their learning throughout the semester by compiling a 'leadership portfolio' that documents their interactions with students and their progress throughout the course. The final portfolio submission will also include their semester plan, critical reflections, and leadership philosophy. Students will be given an assignment guideline that clearly states the expectations placed on their final portfolio submission, as well as the grading rubric the instructor will use to evaluate it. Students may speak with the instructor at any point about their portfolio.

Classroom Contribution (5%)
Students are asked to be present and engaged in class discussion and activities. Please refer to the expectations laid-out under 'Participation Norms' below for further details.

ACADEMIC INTEGRITY AND PROFESSIONAL CONDUCT:

Students are expected to conduct themselves in all aspects of the course at the highest level of academic integrity. Any student found to commit academic misconduct will be dealt with according to the Faculty and University practices. More information is available at [hyperlink removed]

Students are encouraged to consult the Faculty of Engineering Student Code of Conduct at [hyperlink removed]

Plagiarism

Plagiarism is the act of presenting the ideas or works of another as one's own. This applied to all material such as essays, laboratory reports, work term reports, design projects, seminar presentations, statistical data, computer programs, research results, and theses. The properly acknowledged use of sources is an accepted and important part of scholarship. Use of such material without acknowledgement is contrary to accepted norms of academic behaviour.

Information regarding acceptable writing or email practices is available through the Writing Centre. For a full listing of what constitutes academic offense please refer to [hyperlink removed]

Attendance

Students are required to attend the seminar class on a regular basis, and document their practicum hours. If students must take a prolonged leave of absence from class for legitimate reasons (such as serious illness, family obligations, or varsity sports commitments), they must inform the instructor of their anticipated dates away and may have to provide documentation. Further to this point, alternative assessment arrangements can be discussed with the instructor, but unless rearranged, absentee students must still observe all assignment deadlines and course requirements.

Missed Classes

You are responsible for obtaining notes, information, instructions, class alterations, etc. from the missed classes. In other words, it is not the responsibility of the instructor to see that you are caught up. It is recommended that you choose a buddy in your first week of classes so that you can email him / her if you are missing material from class.

Late Submission Policy

All written assignments must be passed in at the beginning of the class period on the day they are due. Passing them in later that day will result in a loss of points off the assignment's mark. Assignments passed in one or more days after the due date will be docked 5% for each day they are late and no assignment will be accepted more than one week late. Only in the case of very serious circumstances or illness will the instructor consider an exception to this policy and a student in this situation must provide the instructor with the requested written documentation to support the need for compassionate grounds.

Grade Appeals

The instructor will go over any graded assignments in class. This time is not for debating scores, however; it is a time to understand exam and assignment questions and answers. If you believe your grade is incorrect and would like to appeal the score you have two choices: (1) email the instructor with your appeal, carefully explaining why you feel you deserve more points and you will be notified of the decision by email within a couple of days, and/or (2) make an appointment to discuss the issue in-person. The first appointment will be a minimum of 24 hours after the exam/paper is turned back to you. Also, please note that grade appeals must be made within 7 days of receiving your original grade.

Written Assignments

All assignment descriptions will specify how written assignments will be submitted. Assignments must meet the format of the assignment description. Failure to do so will mean a loss of marks and emailed assignments will not be accepted. Please note that students must use APA format.

Participation Norms

There are many ways you can participate in this class. Asking thoughtful questions and participating in meaningful discussion and debate in class is one way. A second way - perhaps more appealing to those uncomfortable with speaking up in class - is participating in small group discussion, activities and exercises. Students can also contribute to the online discussion forum.

Parameters for participation in both in-class and online discussions are simple. Participate in a manner that is informed and respectful. Listen before you speak, after contemplating what you're going to say, with thoughtful consideration of readings and learning materials. Doing this will ensure you are a valuable contributor to the classroom discussion.

You are expected to treat the instructor and your classmates with respect in-class and online. Students who display excessive rudeness; this includes, but is not limited to: being verbally disrespectful to classroom participants, engaging in excessive use of technology, and blatantly ignoring the lecture may be asked to leave the class. Being late for class can also be very disruptive and students who are more than 10 minutes late may not be permitted to attend class.

Technology Policy

Cell phones and pagers must be turned off or in the silent position during class (silent does not include vibrate). If for a serious reason you are on call during class, please inform the instructor before class begins. A student whose cell phone rings, or is texting during class, may be asked to leave for the remainder of the class. Laptops may be used in class purely for the purpose of taking notes (not for activities such as surfing the net, chatting or email). Failure to follow the technology policy of this class may severely affect the student's grade.

Communicating with the Instructor

It is very important that you check your email and online class account regularly for any correspondence regarding the class. Ensure that the instructor email is on your email 'safe list' so emails from your instructor go straight into your inbox. Some email accounts may be recognized as spam by the email system so you are encouraged to use your email account as well when corresponding with the instructor to ensure messages are received.

Except for weekends, holidays, or other absences (which you will know about) the instructor will respond to emails within 24 hours. If you have a concern that may need special accommodation, please approach the instructor after class, during office hours, or via email. If you have any technical concerns they can be addressed in the Library.

INCLUSION AND EQUITY:

Students who require physical or academic accommodations are encouraged to speak privately to the instructor so that appropriate arrangements can be made to ensure your full participation in the course. All conversations will remain confidential.

The university experience is enriched by the diversity of viewpoints, values, and backgrounds that each class participant possesses. In order for this course to encourage as much insightful and comprehensive discussion among class participants as possible, there is an expectation that dialogue will be collegial and respectful across disciplinary, cultural, and personal boundaries.

STUDENT ASSISTANCE: Student Affairs and Services offers help and support in a variety of areas, both academic and personal. More information can be found at [hyperlink removed] Academic and non-academic support services on campus, include but are not limited to [list removed].

ADDITIONAL INFORMATION:

Caveat on the nature of the syllabus

The instructor reserves the right to make adjustments to the syllabus in extenuating circumstances or by mutual agreement between the instructor and the students. Any changes will be communicated to students immediately, and disseminated in-class, and through the online class learning hub.

Instructor's Research

To improve the quality of teaching in this subject area your instructor occasionally analyzes data about student learning that is gathered naturally in the course of teaching, and may present these findings at conferences or in academic publications. Unless you give signed consent, data specific to your course work and participation will not be included in such research. During course evaluation time, or after the course is over, the instructor may hand out consent forms or email you a request to use your work outside of the course. You are free to decline participation or withdraw participation at any time. Any signed consent forms will not be seen by the instructor until after the final grades have been submitted.

APPENDIX S: Course Reading List: Journal Abstracts

WEEK 1: Peer Mentoring Introduction (course text overview)

WEEK 2: Peer mentoring & higher learning theory

Newman, M. (2012). Calling Transformative Learning Into Question: Some Mutinous Thoughts. *Adult Education Quarterly*, *62* (1), 36-55.

The author identifies six flaws that commonly occur in explanations of transformative learning, and suggests that transformative learning may not exist as an identifiable phenomenon. He proposes that we abandon the term transformative learning, and adopt the straightforward term good learning. Good learning, he argues, has nine aspects: instrumental, communicative, affective, interpretive, essential, critical, political, passionate, and moral.

WEEK 3: Introduction to Critical Reflection

Dietz-Uhler, B. & Lanter, J.R. (2009). Using the Four-Question Technique to Enhance Learning. *Teaching of Psychology, 36* (1), 38-41.

To assess the effect of a 4-question reflective learning technique on quiz performance, students engaged in an interactive activity, responded to 4 questions to encourage analyzing (i.e., what was learned), reflecting (i.e., why it is important), relating (i.e., how the material related to their personal lives), and generating (i.e., what questions they now have about the material), and took a quiz on the studied material. Quiz performance was better for students who responded to the 4 questions prior to the quiz than for those who did so after the quiz. Students also perceived the 4-question technique to be enjoyable and successful in meeting its objectives. We discuss how this simple technique effectively promotes students' understanding and memory.

WEEK 4: Problem-based Learning

Gyori, B. (2013). Mentorship Modes: Strategies for Influencing Interactive Learners. *Interdisciplinary Journal of Problem-based Learning*, *7*(1), 173-185.

In the age of the Internet, students are clamoring for immersive and participatory learning experiences, but how can teachers share autonomy without losing control of their classrooms? In an effort to address this important question, this article suggests three mentorship modes that educators can employ in order to effectively engage with today's interactive learners. Lecture-based instruction is a single mode form of teaching in which information is disseminated by a lone authority-figure. In contrast, learning-centered mentorship is a three-mode process in which autonomy is shared and authority flows in multiple directions at once: bottom-up (modeling), laterally (collaborating), and top-down organizing and supervising). This work draws on research and theories related to student-centered pedagogy, as well as the trial and error experimentation of the author and interviews with successful participatory educators working at Tribeca Flashpoint Media

Arts Academy in Chicago, a school devoted almost exclusively to problem-based and project-based learning.

WEEK 5: Active Learning

Zepke, N. & Leach, L. (2010). Improving Student Engagement: Ten Proposals for action. *Active Learning in Higher Education, 11*(3), 167-177.

Since the 1980s an extensive research literature has investigated how to improve student success in higher education focusing on student outcomes such as retention, completion and employability. A parallel research programme has focused on how students engage with their studies and what they, institutions and educators can do to enhance their engagement, and hence success. This article reports on two syntheses of research literature on student engagement and how this can be enhanced. It first synthesizes 93 research studies from ten countries to develop a conceptual organizer for student engagement that consists of four perspectives identified in the research: student motivation; transactions between teachers and students; institutional support; and engagement for active citizenship. Secondly, the article synthesizes findings from these perspectives as ten propositions for improving student engagement in higher education. It concludes by identifying some limitations with the conceptual organizer and one suggestion for developing a more integrated approach to student engagement.

WEEK 6: Power & Leadership

Plunkett-Tost, L., Gino, F., & Larrick, R.P. (2013). When power makes others speechless: The negative impact of leader power on team performance. *Academy of Management Journal, 56*(5), 1465-86

We examine the impact of the subjective experience of power on leadership dynamics and team performance and find that the psychological effect of power on formal leaders spills over to affect team performance. We argue that a formal leader's experience of heightened power produces verbal dominance, which reduces team communication and consequently diminishes performance. Importantly, because these dynamics rely on the acquiescence of other team members to the leader's dominant behavior, the effects only emerge when the leader holds a formal leadership position. Three studies offer consistent support for this argument. Implications for theory and practice are discussed.

WEEK 7/8 (midterm-break): Effective Leadership

Owens, B. P., & Hekman, D. R. (2012). Modeling How To Grow: An Inductive Examination Of Humble Leader Behaviors, Contingencies, & Outcomes. *Academy Of Management Journal, 55*(4).

Although a growing number of leadership writers argue leader humility is important to organizational effectiveness, little is known about the construct, why some leaders behave more humbly than others, what these behaviors lead to, or what factors moderate the effectiveness of these behaviors. Drawing from 55 in-depth interviews with leaders from a wide variety of contexts, we develop a model of the behaviors, outcomes, and contingencies of humble leadership. We uncover that leader humility involves leaders modeling to followers how to grow and produces positive organizational outcomes by leading followers to believe that their own developmental journeys and feelings of uncertainty are legitimate in the workplace. We discuss how the emergent humility in leadership model informs a broad range of leadership issues, including organizational development and change, the evolution of leader-follower relationships, new pathways for engaging followers, and integrating top-down and bottom-up organizing.

WEEK 9: Sex & Sexism

Heilman, M.E. & Okimoto, T.G. (2007). Why are women penalized for success at male tasks?: The implied communality deficit. *Journal of Applied Psychology, 92, 81-92.*

In 3 experimental studies, the authors tested the idea that penalties women incur for success in traditionally male areas arise from a perceived deficit in nurturing and socially sensitive communal attributes that is implied by their success. The authors therefore expected that providing information of communality would prevent these penalties. Results indicated that the negativity directed at successful female managers-in ratings of likability, interpersonal hostility, and boss desirability-was mitigated when there was indication that they were communal. This ameliorative effect occurred only when the information was clearly indicative of communal attributes (Study 1) and when it could be unambiguously attributed to the female manager (Study 2); furthermore, these penalties were averted when communality was conveyed by role information (motherhood status) or by behavior (Study 3). These findings support the idea that penalties for women's success in male domains result from the perceived violation of gender-stereotypic prescriptions.

WEEK 10: Difference & Discrimination

Cortina, L.M. (2008). Unseen injustice: Incivility as modern discrimination in organizations. *Academy of Management Review, 33,* 55-75.

This article advances a theory of incivility as a veiled manifestation of sexism and racism in organizations. To support this argument, I draw from social psychological research on modern discrimination. The result is a multilevel model of selective incivility, with determinants at the level of the person, organization, and society. Selective incivility could be one mechanism by which gender and racial disparities persist in American organizations, despite concerted efforts to eradicate bias. I dis-cuss scientific and practical implications.

WEEK 11: Ethics & Pragmatism

Emison, G.A. (2006). The Complex Challenges of Ethical Choices by Engineers in Public Service. *Science and Engineering Ethics*, *12*, 233-244.

This paper proposes that engineers in public service are confronted with unavoidable complexity in their ethical considerations. The complexity begins with interactions among venues of ethical choices. Engineers must make ethical choices simultaneously at the individual, professional, organizational and societal levels. These ethical domains often conflict. The complexity also stems from situations in which physical properties may remain stable, but important social, economic, institutional and political conditions can change substantially. The paper proposes that the reflective learning approach of pragmatism can help with these challenging situations. This approach depends upon employing Dewey's five stage process of inquiry to engage the ethical complexity inherent in the practice of engineering in the public service.

APPENDIX T: Course Assignments

CRITICAL REFLECTION ASSIGNMENT GUIDELINES

Write a short essay (1500 - 2000 words) that analyzes at least two or more readings we have discussed in-class prior to the due date. These readings can include chapters from The World in 2050 and/or the academic articles reviewed in-class.

Do not choose more than two articles in an effort to impress your instructor. You are being graded on how you can compare/contrast/create connections between concepts. If you choose too many articles you may spend most of your word count allotment recounting information, not synthesizing it which is what you are being graded on as this shows higher-order thinking skills (Refer to Bloom's Revised Taxonomy for further information)

This is not a research essay, and as such you are not required to provide an extensive history of the theories discussed in the articles or book chapters you are analyzing. You are, however, asked to show an awareness of the main themes and messages being communicated in the articles you select and be able to relate them to your practice as an engineer, educator, and leader.

Essay Format:

Introduction
250 - 500 words (or thereabouts)

This section provides a brief overview of what you are going to be discussing, how you are going to discuss it, and why you are interested in discussing it. This is largely a descriptive process, wherein you should outline what you are going to do with your essay, while also including one to two sentences that summarizes the particular thoughts/conclusions you have concerning your essay topic.

Questions to answer:

1. What articles or chapters have you selected?
2. What are the main points these readings raise?
3. Why are these main points relevant to your essay?

Analysis
750 – 1000 words (or thereabouts)

This section should follow from the introduction by expanding on the main themes or points of information of the readings you selected. Analyze the information/themes to show how you see these themes working together or opposing each other. Provide an opinion on the value or importance of this information by referring to your experience as an engineer, educator, and/or leader. Comment on how these themes or points of information can be applied to your practice as an engineer, educator, and/or leader.

Questions to answer:

1. What are the main themes or points of information in your selected readings?
2. How are these themes or points of information related/unrelated?
3. Are there elements of the arguments or information presented in your selected readings that you do not agree with?
    a. If so, why?
    b. What would you propose instead?
4. How can you adapt the information from these articles to use in your practice as an engineer, educator, and/or leader?
    a. What information would you choose to use?
    b. Why would you use it?
    c. How would you use it?
    d. What makes it important to your practice as an engineer? Educator? Leader?
5. How would use the information in your selected articles to improve upon or redesign engineering education or the engineering profession?

**** You do not have to answer all these question in your paper; they are suggested questions to get you started and help you structure your writing****

Conclusion
150 – 250 words (or thereabouts)

This section should briefly summarize the main points of your essay, and can also be a place for you to suggest further questions or ideas you would like to explore as a result of your reflection.

CRITICAL REFLECTION RUBRIC

Criteria	Exceptional (5)	Proficient (4)	Progressing (3)	Not yet Ccompetent (2)	Unacceptable (0-1)
Accuracy (Grasp of material)	Represents ideas, evidence, or conclusions covered in lecture, readings, class discussion, and practicum, in an accurate, fair, and eloquent manner. Shows a firm understanding of the implications of arguments presented.	Represents ideas, evidence, or conclusions covered in lecture, readings, class discussion, and practicum, in an accurate manner.	Represents ideas, evidence, or conclusions covered in lecture, readings, class discussion, and practicum, in an accurate manner, but not sufficiently clear. Minor inaccuracies.	Represents ideas, evidence, or conclusions covered in lecture, readings, class discussion, and practicum, in an accurate manner. Does not distinguish between major ideas and less relevant points.	Misrepresents Ideas, evidence, or conclusions covered in lecture, readings, class discussion, and practicum. Major inaccuracies.
Depth of reflection	Demonstrates a conscious and thorough understanding of the skills and strategies acquired from education and practicum experience.	Demonstrates a thoughtful awareness of the skills and strategies acquired from education and practicum experience.	Demonstrates a basic awareness of some of the skills and strategies acquired from education and practicum experience.	Demonstrates a limited awareness of just one or two skills and strategies acquired from education and practicum experience.	Demonstrates little to no awareness of the skills and strategies acquired from education and practicum experience.
Clarity and coherence	Consistently precise and unambiguous wording, clear and lucid sentence structure. Sentences are varied in kind, length and effect. (5)	Mostly precise and unambiguous wording, mostly clear sentence structure.	Some imprecise or ambiguous wording. Minor issues in sentence structure. Sentences may be wordy, rambling or awkward.	Frequent imprecise or ambiguous wording. Confusing sentence structure.	Consistently imprecise or ambiguous wording. Confusing sentence structure. Difficult to understand.
Demonstrated growth	Exceptional growth as a reader, writer, and thinker, with the ability to consistently apply skills and strategies independently and effectively.	Strong growth as a reader, writer, and thinker, with the ability to apply skills and strategies effectively and independently most of the time.	Demonstrates acceptable growth as a reader, writer, and thinker, with the ability to apply skills and strategies effectively some of the time.	Inconsistent or limited growth as a reader, writer, and thinker, with the ability to apply skills and strategies on a limited basis or without even results.	Demonstrates little to no growth as a reader, writer, and thinker, with little or no ability to apply skills and strategies.

LEADERSHIP PHILOSOPHY ASSIGNMENT GUIDELINES

Throughout the course we have examined various topics and themes related to engineering, teaching and learning, as well as leadership.

Reflecting back on the various course readings, class discussion, practicum placement, and your own engineering education and professional (i.e. internships) practice, write a short document (1000 – 1500) words that speaks to the following:

i. *How engineering can impact local, national, and global communities*
ii. *What are important areas of local, national, and global change for engineering to address*
iii. *Your view on how an individual creates change and the circumstances for change*
iv. *Your understanding of yourself as a leader, and what it means to be an effective leader*

You do not have to discuss these themes in order, and you should **not** cite or explicitly refer to any course readings throughout the document. This piece of writing is meant to be something that you can refer back to as your practice as a professional engineer develops.

It is also intended to be a document that may be useful as a supplementary addition in an employment application, or re-worked at an appropriate time in a bid for promotion or competition to lead a particular work project.

Therefore, this write-up should read as though it is addressed to a person, or group of persons, that are interested in hearing your thoughts on what it means to be an engineer, a leader, and an effective agent of organizational change.

Make sure you offer a nuanced and complex discussion of leadership. Do not over focus on the first two discussion points. It is the latter two discussion points that should make up the bulk of your write-up, and it should provide a discussion of leadership that accounts for some of the course themes around gender, ethnicity, power, and ethics that have been explored in-class and in-text.

PRACTICUM PORTFOLIO ASSIGNMENT GUIDELINES

Practicum portfolios reflect the work you have done in the course as a mentor, and the growth you have experienced as a senior engineering student. They should be a compilation of all the work you have done in the course (i.e. previous assignments), records of communications (i.e. emails) with students and host instructor team, meeting notes from student/faculty discussions, and any personal notes you have kept about your mentoring experience.

Above and beyond this, you are asked to submit the following:

- 1000-1500 word reflection on your individual ‘growth challenge’ given to you during the mid-term portfolio discussion. Answer the following questions:
    - What was your challenge?
    - Did you think this was a useful/appropriate challenge?
    - Did you act on your challenge?
    - If so, what did you learn or experience undertaking your challenge?
    - How, if at all, do undertaking you challenge help you grow as an engineer/leader/person?

- 1000-1500 word summary of your experience as a curricular peer mentor and as a participant in the pilot program (open-ended, discuss as you see fit)

APPENDIX U: PAR Workshop Presentation Outline

Presentation Outline

1. Introduction (5 minutes)
   Lead: Claire

2. Academic Survival (15 minutes)

   a. Study smart (*Claire)*
      i. Study skills and habits
   b. Student life (*Cliff)*
      i. Engineering as family
   c. Disciplines (*Katy*)
      i. You're here to learn, not to know it already
      ii. Everything you learn in first year will connect to your discipline
      iii. How to choose your discipline

3. Being a Professional (15 minutes)
   Lead: Everyone – speaking to panel of senior students
   a. Academic options (*Cliff*)
   b. Work terms (*Katy*)
   c. Reality on-the-ground (*Claire*)

4. Questions (5 minutes)
   Lead: Everyone

5. Conclusion
   Lead: Claire

APPENDIX V: PAR Workshop Poster Advertisement