INDIGENOUS INITIATIVES IN ENGINEERING EDUCATION IN CANADA: COLLECTIVE CONTRIBUTIONS

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Abstract – The purpose of this Participatory Action Research (PAR) project is to share with the CEEA-ACEG membership the Indigenous initiatives being taken in CEAB accredited engineering programs across Canada. We received contributions from 24 institutions and 4 organizations, from which 11 categories of initiatives emerged. The intention is to create an ethical space where Indigenous and non-Indigenous engineering educators can learn from one another, and work together guided by Etuaptmumk (Two-Eyed Seeing), to advance Indigenous ways of knowing and being in engineering in Canada. This project is ongoing. Contact us if you wish to contribute and/or engage in the projects arising from this work.

Keywords: Indigenous initiatives; engineering education; TRC of Canada; Calls to Action; Etuaptmumk Mi'kmaw worldview; participatory action research (PAR).

1. INTRODUCTION

There is a movement in the engineering profession in Canada to increase Indigenous representation and belonging [1]. The engineering education field is contributing to the repair and building of the relationship between the engineering profession and the Indigenous communities in Canada through the enhancement of engineering education in significant and culturally sensitive ways. This is in alignment with the Truth and Reconciliation Commission of Canada 94 Calls to Action, which calls upon federal, provincial, and territorial governments in consultation and collaboration with Survivors, Aboriginal peoples, and educators to integrate Indigenous knowledge and teaching methods into post-secondary curricula [2]. Indigenous initiatives in engineering education have started in diverse ways and are

at different stages in engineering institutions across the country. However, most of this work is being undertaken by small sub-groups or individuals within institutions, with few connections to others doing similar work elsewhere. To support and advance this work, it is critical to share the initiatives that are taking or have taken root across the country, and build bridges among our institutions.

As such, a team of Indigenous and non-Indigenous engineering educators from institutions across Canada have come together to share our involvement with Indigenous initiatives in engineering education, and develop a common understanding of what is happening in CEAB accredited engineering programs. The team was built both organically and mindfully, through connections with the CEEA-ACEG membership, the CODE (Council of Ontario Deans of Engineering) Working Group, the .caISES (Canadian Indigenous Science and Engineering Society) Annual Gathering in February 2020, and the Decolonizing and Indigenizing Engineering Education Network facilitated by the Engineers Canada Diversity, Equity, and Inclusion Manager. We were mindful of having both Indigenous and non-Indigenous representation, with a clear understanding of the importance of and commitment to walking together on this journey. We also aimed to have national representation, to include a diversity of perspectives while engaging in the work. In this way, we have many Indigenous and institutional perspectives represented on this team. We envisioned using the CEEA-ACEG conference proceedings as a mechanism to gather information on Indigenous initiatives in engineering education, creating a space to share and develop this work. Thus, we invited engineering educators in institutions from across Canada to share the Indigenous initiatives in which they are involved, in order to present a national view of the work being done,

and encourage its continuation and exponential growth. The scope for this paper is Indigenous initiatives in engineering education in Canadian Engineering Accreditation Board (CEAB) accredited programs and associated national engineering organizations in Canada.

The purpose of this work is to: (i) provide a cohesive overview of the Indigenous initiatives being undertaken in accredited engineering programs across the country; (ii) build bridges between institutions so that Indigenous and non-Indigenous engineering educators can learn from, and support one another in this work; (iii) create an “ethical space” [3] in engineering education for Indigenous and western knowledges, perspectives, principles and values to co-exist; and (iv) inspire CEEA-ACEG to work together to significantly advance Indigenous initiatives in engineering.

The contributions were rich and detailed. We are reporting preliminary findings here, with plans to publish the study in full underway.

2. GUIDING PRINCIPLES OF THE WORK

2.1. Two-Eyed Seeing

As we embarked on this work in partnership with our Indigenous and non-Indigenous team members and contributing colleagues, we came to realize that one Indigenous framework that can guide us is *Etuaptmumk*, an Mi'kmaw worldview brought forward by Elder Albert Marshall [4]. This worldview was first introduced to us by Leah Fontaine, an Anishinaabe-Métis-Dakota Indigenous Initiatives Educator at the University of Manitoba [5]. We humbly describe some of Elder Albert Marshall's teachings with his permission here, shared via his work with the Institute for Integrative Science and Health¹, as they provide an important guiding principle for this work.

¹No longer in existence.

Etuaptmumk (which translates to *Two-Eyed Seeing* in English) is described by Elder Albert Marshall as “learning to see from one eye with the strengths of Indigenous knowledges and ways of knowing, and from the other eye with the strengths of Western knowledges and ways of knowing ... and learning to use both these eyes together, for the benefit of all” [4]. This understanding enables educators to embark on a “co-learning journey” [4]. Dr. Cheryl Bartlett, Canada Research Chair in Integrative Science from 2002-2016, explained that if an education system ignores who one is, or who one thinks they are, and the curriculum does not include one's understandings, then we deny students' ability to form “a well-balanced and deep understanding” of who they are [6]. In fact, we are inhibiting self-actualization, a primary human need [7]. Fundamentally, the education system does not teach us to look at knowledge from multiple perspectives, and if our future generations are going to survive, Elder Albert Marshall, and the late Elder Murdena Marshall, advise that we must use the best “tools” from the western world and the best “tools” from the Indigenous Peoples and “conjoin”

these worlds [4]. Elder Albert Marshall is careful to express that the Indigenous or western views are not monocal, but rather comprised of multiple and diverse views, vital to creating a better world:

Mi'kmaw First Nations' understandings are but one view in a multitude of Aboriginal and Indigenous views ... and similarly so are the various disciplines in the Western sciences. All of the world's cultures (which we take include Western science) have understandings to contribute in addressing the local to global challenges faced in efforts to promote healthy communities... *Etuaptmumk* – Two-Eyed Seeing adamantly, respectfully, and passionately asks that we bring together our different ways of knowing to motivate people, Aboriginal and non-Aboriginal alike, to use all our understandings so we can leave the world a better place and not comprise the opportunities for our youth (in the sense of Seven Generations) through our own inactions.

The Integrative Science and Health team “acknowledge[d] the need for... an ‘ethical space’ within the precarious relationship between Indigenous peoples and the Western world.” In this work, we are committed to creating an “ethical space” [3] in engineering education, where Indigenous ways of knowing and being are recognized, respected, and taught in partnership with western perspectives. As “Métis voyageurs were a bridge between cultures” [8, p. 10], we look in this work to build bridges among Indigenous and western worldviews to enhance engineering education.

2.2. Talking/Sharing Circle

The project grew from the intention to gather at CEEA-ACEG 2020 conference to discuss Indigenous initiatives in engineering education with the contributors of this work and conference attendees via a sharing circle led by the territory Elders. Talking circles are an important practice in many Indigenous Nations in North America. Regional protocols may vary but the intent throughout is common. Talking circles are a representation of Indigenous epistemologies and ontologies which reflect the value of interrelationships and the value of stories. In a talking circle, no one voice or perspective is held with more value or weight than another. Participants are encouraged to show up with their whole self, mind, body, spirit and heart, and to practice active listening throughout. Cancelling the conference placed increased importance on collecting data through contributors to communicate this work to the membership. We engaged in a cyclical process to connect contributors and the team in a circle. We followed guiding principles of a talking/sharing circle, listening to speakers with empathy and compassion, and treating the space – i.e., the work and burgeoning relationships – with respect. (For detailed information on talking/sharing circles see [9-11].)

3. METHODOLOGY

We designed this work using a participatory action research (PAR) methodology. This is a qualitative research approach that finds its roots in action research [12], where data is collected and analyzed to generate practical knowledge to make change [13]. PAR aligns with Indigenous values and approaches to evaluation [14-17], aligned with “participatory and empowerment models that allow meaningful impact from the community” [18, p. 36]. It honours the epistemology of “collective interdependence” held by Māori people [19, p. 300] and reflective of many Indigenous cultures [14][16-18]. PAR enables the co-creation of meaning with participants “to bring about social justice and change” [20, p. 1394]. It is a suitable approach as it supports the participation of a community – in this case engineering educators – and makes space for the interaction of Indigenous and western worldviews. It reflects Indigenous circular worldviews of interconnectedness through its iterative cycle of planning, implementing, observing and critically reflecting [21-23]. It supports an Indigenous voice in this work, a voice that has been missing far too often in engineering works in the past (e.g. [24]) and present (e.g. [25]).

3.1. Intentions

Our aim in gathering information on Indigenous initiatives in engineering education is for collaboration and not competition. Our intention is to build a common understanding of the work so that Canadian engineering educators can learn from these efforts and build on or begin their work in their own institutional contexts.

3.2. Scope

The work represented here is explicitly focusing on efforts in engineering, and to CEAB accredited programs and connected national engineering organizations. Many post-secondary institutions have Indigenous programs and services available campus-wide, either in addition to or in lieu of engineering-specific Indigenous initiatives. Contributors cited campus-wide Indigenous Student Centres, Teaching and Learning Centres, and access/bridging programs. For this paper, only the information specifically connected to or developed for engineering programs were included. As well, limiting the scope to accredited programs does not negate the Indigenous initiatives taken in engineering education in the North, at Yukon College for example, or in diploma or technology programs, or in Professional Associations. There is important work in diverse contexts to advance Indigenous engagement and achievement and demonstrate respect and recognition for Indigenous Peoples in engineering education not represented here.

It is also important to understand that the information presented here is not exclusive: it is not the only work being done in Indigenous initiatives in CEAB accredited

engineering programs in Canada. Firstly, we have been unable to gather information from all institutions in this scope within the given timeframe. For example, we only have two contributions from institutions in Quebec, which means we are missing important approaches and perspectives. Secondly, the contributions from the institutions represented here are not intended to be read as complete. There are students, faculty and/or staff who are working on Indigenous initiatives in engineering education in these institutions whose voices are not represented due to being unaware of the work, capacity, or other reasons. We apologize to those who are missed. We are grateful to, and acknowledge all those who were able to contribute at this time. We understand that your contributions are not intended as complete stories, and do not capture all voices.

This work is being done in the spirit of truth and reconciliation, and has been entered into with good will and intentions. It is humbly offered as a place to share our knowledges, build understandings, and create an explicit, inclusive, ethical, and national space for galvanizing Indigenous initiatives in engineering education in Canada. We ask our readers to interpret the work in this way.

4. PRELIMINARY RESULTS

There are 279 accredited engineering programs at 44 higher education institutions across Canada [26]. We received contributions from 24 of these institutions, and four engineering organizations (see Table 1).

Contributions ranged from one paragraph to several pages. All contributions except one were via personal and professional networks. SFU was connected through their presentation at the Meeting of Western Deans, Associate Deans, and Key Advisors in conjunction with .caISES in February 2020. No contributions came via the CEEA-ACEG monthly newsletter.

Receiving contributions took time, predominantly due to the collaborative approach taken. Most contributors approached colleagues and/or Deans working on Indigenous initiatives from the outset, or sought confirmation/contributions when asked to review the data analysis and emergent categories. Thereby, the majority of the institutional information here are presented with collective understandings.

When asked to review their institutional data once it was analyzed, contributors were exposed to the categories that emerged from the complete data set. Subsequently, contributors were able to enhance their contributions with additional details stimulated by the categories. Thus, data were collected in a snowball method generated by member-checking cycles and broadened understandings.

Table 1: Data Contributions: Institutions & Recruitment.

Institutions (n = 24)	Abbr.	Recruitment/Connection
University of Victoria	UVic	Decolonizing & Indigenizing EngEd Network (EngC)
University of British Columbia*	UBC	CEEA-ACEG, .caISES 2020
University of British Columbia-Okanagan	UBC-Ok	Decolonizing & Indigenizing EngEd Network (EngC)
Simon Fraser University	SFU	Presentation at Western Deans Meeting
University of Alberta	U of A	.caISES 2020
University of Calgary*	U of C	CEEA-ACEG
University of Saskatchewan*	U of S	CEEA-ACEG
University of Regina	U of R	University Website
University of Manitoba*	U of M	CEEA-ACEG, CODE Working Group
Western University of Ontario	UWO	CEEC; CIAC
University of Waterloo*	U of W	CEEA-ACEG
McMaster University	McM	CEEC
Ryerson University	RU	CEEC
University of Toronto	U of T	CEEA-ACEG
Conestoga College	CC	CEEA-ACEG
Queen's University	Q's	CODE Working Group, CIAC
Carleton University*	CU	CEEA-ACEG
Université d'Ottawa /University of Ottawa	U of O	CEEC
Université Concordia	UCon	CEEA-ACEG
McGill University	McGill	CEEA-ACEG, CEEC
University of New Brunswick	UNB	CEEA-ACEG, CEEC
Université de Moncton	UdeM	CEEC
University of Prince Edward Island	UPEI	CEEA-ACEG
Memorial University of Newfoundland	M UN	CEEA-ACEG
Organizations (n=4)	Abbr.	Recruitment/Connection
Engineers Canada	EngC	Decolonizing & Indigenizing EngEd Network, AISES
Canadian Indigenous Advisory Council to AISES (Am. Indian Science & Eng. Soc.)	CIAC	AISES
Canadian Engineering Education Challenge*	CEEC	CEEA-ACEG, CODE Working Group
Canadian Federation of Engineering Students	CFES	CEEC

Note: *Team Members' Home Institutions

From the 28 contributions, 11 categories characterizing Indigenous initiatives in engineering education emerged:

1. Engineering/STEM Outreach
2. Engineering Access & Bridging Programs or Mechanisms
3. Provincial & National Collaborations/ Presence/Research in Engineering & Engineering Education
4. Committees/Councils/Strategies in Engineering
5. Engineering Faculty & Institutional Positions
6. Engineering Curricula

7. Elders/Knowledge Keepers/Indigenous Community Members involved in Engineering Education
8. Engineering Student Organizations
9. Engineering Faculty Training/ Workshops
10. Engineering Student Training
11. Indigenous Culture in Engineering

Institutions are at different stages of implementation in the work represented in each of these categories, ranging from planning or upcoming to more mature efforts. Evidence of explicit work in Indigenous initiatives in engineering education in this data set dates back 35 years, with the Indigenous Engineering Access Program (ENGAP) successfully running at the U of M Manitoba since 1985. Additional activity is seen a decade ago at Q's, in the organization of a Dean's Circle of Advisors composed of Indigenous professionals in engineering, education, and business, delegated to advise on programming strategy for the Faculty of Engineering and Applied Science, first constituted in 2010/11. Six years ago, in 2014, a Coordinator who supports Indigenous student supports and initiatives was hired by the College of Engineering at the U of S. In 2016, Engineers Canada published the report, *Indigenous People's Access to Post-Secondary Engineering Programs: A Review of Practice Consensus* [27], and struck an Indigenous Peoples' Participation in Engineering sub-committee to Engineers Canada's Equitable Participation in Engineering. From the year 2017 and on, the data shows intensified efforts in Indigenous initiatives in CEAB accredited engineering programs, with many new initiatives forthcoming. The following sections are organized via the 11 emergent categories.

4.1. Engineering/STEM Outreach

Sixteen institutions (UBC; UBC-Ok; U of A; U of C; U of S; U of R; U of M; UWO; U of W; McM; U of T; Q's; CU; U of O; McGill; UPEI) and one organization (EngC) are engaged in engineering/STEM outreach, and two institutions (SFU, RU) have plans to implement outreach. Outreach includes programs such as workshops and camps to attract potential Indigenous students to engineering.

4.2. Engineering Access & Bridging Programs or Mechanisms

Thirteen institutions are planning to have (n =6)(SF; U of C; U of R; RU; U of T; UNB) or already have (n=7)(UBC-Ok; U of A; U of S; U of M; U of W; Q's; UPEI) engineering access/bridging programs or mechanisms in place. These programs are either wholly provided within the engineering institution (e.g. U of M ENGAP program and Aboriginal Access to Engineering at Q's), or are combined with institution-wide supports, such as Indigenous student centers and/or services. They

function to support students' academic, social, personal, emotional, professional and/or financial needs.

4.3. Provincial & National Collaborations/ Presence/Research in Engineering & Engineering Education

Seventeen contributing institutions (UVic; UBC; UBC-Ok; U of A; U of C; U of S; U of M; UWO; U of W; McM; U of T; Q's; CU; UCon; McGill; UNB; MUN) and all four contributing organizations are involved in provincial or national collaborations and/or research connected to Indigenous initiatives in engineering education.

4.4. Committees/Councils/Strategies in Engineering

Fourteen institutions have (UVic, UBC, UBC-Ok, U of S, U of M, RU, U of T, Q's, CU, UCon, McGill, and UdeM) or are planning (SFU; U of C) strategic plans/initiatives/blueprints/calls to action for Indigenous engagement and advancement in engineering and/or decolonizing and Indigenizing engineering education. Seven of the 14 institutional plans are connected to and/or supported by university-wide strategic plans for Indigenous recognition, engagement and advancement in post-secondary education. EngC and CFES also have strategic plans for Indigenous access and partnership, respectively, in engineering. U of A have faculty sitting on committees/councils to forward Truth and Reconciliation; U of W have a Community of Practice for Indigenous initiatives in STEM; and UNB establish steering communities for each Indigenous community partnership.

4.5. Engineering Faculty Positions and Positions in Institutions/Organizations

There are 25 positions – 19 appointed, 6 proposed/upcoming – across 12 contributing institutions appointed in engineering programs to advance Indigenous representation, engagement and achievement in engineering education. These include:

Staff (n=1) (U of T upcoming);

- Faculty (including Tenure Track) (n=5) (SF upcoming; U of A; U of M; RU proposed; CU)
- in-Residence (n=6) (U of C potential EIR; U of M – 1 Elder-in-Residence, 1 potential EIR; UNB – 3)
- Teaching Chairs (n=2)(U of C – one appointed, one upcoming)
- Research Chairs (n=3) (UBC-Ok; U of C; U of S)
- Directors/Coordinators (n=3)(U of C; U of S; UdeM)
- Advisors (n=2) (UBC-Ok; U of T)
- Associate/Assistant Dean Equity, Diversity and Inclusion (n=3) (UBC/UBC-Ok; U of C; U of T)

In addition, at UCon, the Director of Decolonizing Curriculum and Pedagogy, Donna Kahérakwas Goodleaf, whose position is housed in the Centre for Teaching and Learning, provides training for all faculty across the

university system on decolonizing and Indigenizing curriculum and pedagogy. Currently she is collaborating with engineering faculty on decolonizing and Indigenizing engineering curriculum and pedagogy, in particular examining the impacts of colonization and settler-engineering technology on Indigenous communities, lands and Indigenous women.

4.6. Engineering Curricula

Seventeen institutions are engaged with or planning curricular initiatives to integrate Indigenous knowledges, perspectives, values and principles into engineering curricula that are either stand-alone programs (n = 1) (McGill), integrated into existing courses (n = 9) (UBC; UBC-Ok; U of A; U of S; UWO; RU; CU; U of O; UCon), or both stand-alone and integrated (n = 7) (UVic; U of C; U of M; U of T; Q's; MUN; and UNB).

4.7. Elders/Knowledge Keepers/Indigenous Community Members involved in Engineering Education

Eleven institutions have engaged (UBC; UBC-Ok; U of A; U of C; U of S; U of R; U of M; RU; U of T; U of O; McGill) or have plans to engage (UVic; UNB) Elders, Knowledge Keepers and/or Indigenous Community members in engineering education. U of M has a part-time Elder-in-Residence in the Price Faculty of Engineering.

4.8. Engineering Student Organizations

There are three institutions who have dedicated Indigenous Engineering Student Organizations (U of A; U of C; U of M) and three institutions that have student groups with dedicated Indigenous foci (UBC; McGill) or are sub-chapters of larger organizations (U of T). Five institutions have student chapters of AISES (UBC; U of S; U of M; Q's, McGill) with a sixth chapter at U of C to be officially recognized. Two Q's engineering students are presently serving as the inaugural and second Canadian National Student Representatives on the AISES Board.

4.9. Engineering Faculty Training/ Workshops

Thirteen institutes have engineering-specific (UVic; UBC upcoming; UBC-Ok; U of C; U of M; U of T upcoming; U of O; UCon) and/or university-wide (U of A; U of S; U of R; Q's; Mem U) access to training that faculty are encouraged to take. Conestoga College (CC) includes Indigenous culture and practices in the mandatory orientation for faculty in all programs including engineering. Faculty training opportunities range from learning about: consulting with Indigenous communities; history and Truth and Reconciliation; Indigenous rights, terminology, cultural technologies, arts, practices, principles, values, ways of knowing and being; experiencing cultural practices and events; and decolonizing and Indigenizing the curriculum. U of T will

train a group to be KAIROS Blanket Exercise facilitators in their engineering program. UBC will offer interested faculty leaders a one-week faculty on-the-land experience in the Tahltan territory (delayed due to COVID-19).

4.10. Engineering Student Training

Ten institutions (UVic; U of C; U of S offered & upcoming; U of R upcoming; U of M; U of W; McM upcoming; U of T upcoming; U of O; McGill) offer/will offer student training. From the contributions, training can be broadly characterized as encompassing knowledge (Indigenous history, colonialism), skills (Indigenous approaches to decision-making, mentorship, leadership, maker skills) and Indigenous principles/values (cultural awareness, including the KAIROS Blanket Exercise, participatory approaches), and is offered via courses/modules, and one certificate program (U of S).

4.11. Indigenous Culture in Engineering

Seven institutions (UBC; U of C; U of S; U of M; U of W; U of T; UNB) and one organization (CEEC) had explicit examples or made specific reference to (or plans to) acknowledging Indigenous culture in engineering. U of T offered the first Indigenous Sharing Circle as CEEA-ACEG 2017 Annual Conference hosts, led by Elder Kim Running Bear McDougall. Over 50 attendees joined.

5. DISCUSSION

Many of us from different institutions and organizations across the nation are working to find out about Indigenous initiatives in engineering education in Canada. We are often unaware of and surprised by the initiatives underway. We realize that it takes time, and the building of relationships to begin to uncover the work being done in this area. This is different than academic work or research conducted in other areas, where information can often be had via publications and other forms of dissemination. This resonates with Indigenous epistemologies regarding interconnectedness, the importance of relationships, and the principles and values regarding knowledge, such as who possesses it, how it is shared, and how it is acknowledged. Knowledge is perceived and respected differently in Indigenous cultures than western cultures [14][19][28][29]. It is interesting to notice this difference in this work being conducted in partnership with Indigenous and non-Indigenous team members and contributors. Moving forward, it would be valuable to explore this community of practice further.

Another interesting finding is how collaborative this space is. Most contributors approached colleagues for collective contributions from the outset, and sought confirmation when reviewing the data analysis. Just as we found in the treatment of knowledge, we see a connection to Indigenous principles and values in the importance of relationships [16][18][28][30] in this space. Again, this

approach is noticeably different than our experiences working in traditional academic research contexts, which is important to acknowledge, and would be valuable to explore further to inform moving forward in good ways.

We see Indigenous initiatives in engineering education that are integrated into the existing post-secondary environments, as well as stand-alone initiatives that are introduced to these milieus, both via courses, activities, events, protocols and culture. There is some discussion around the best way to bring Indigenous ways of knowing and being into engineering education. There are arguments for integration as best reflecting the intent of reconciliation, where Indigenous and non-Indigenous people must walk together in partnership on this journey. This view holds concern that stand-alone initiatives may be “check-boxes” in the process of reconciliation, with reconciliation best demonstrated through immersion rather than separation. Then there are arguments to be made for intensive, concentrated, specialized initiatives, such as courses, specializations, and programs in engineering that focus on Indigenous ways of knowing and being exclusively. We are seeing (UVic) or beginning to see these approaches develop (U of C; U of S; U of M; U of T). We offer that perhaps it is not one way that is better over the other, but it is rather a diversified approach that will strengthen the work to explore the truth and seek reconciliation in engineering education in Canada.. Having multiple, diverse Indigenous initiatives and strategies that broadly span the curricula and culture, fortified by deeply rooted, concentrated and exclusive Indigenous initiatives stratified across mental, physical, emotion, and spirit aspects as guided by the Sacred Hoop or Medicine Wheel [31] will enable us to permeate the western colonial educational system. Thus, we will achieve *Etuaptmunk – Two-Eyed Seeing* – creating an “ethical space” in engineering education where Indigenous ways of knowing and being are recognized and respected, and taught in partnership with western perspectives, ultimately strengthening engineering education.

There was a range of voluntary to mandatory curricula and training on Indigenous Knowledges, perspectives, principles and values offered to students and faculty, with mandatory initiatives generally representing the most recent. For example, UBC-Ok plans to implement an electronic credentialing (i.e., “badging”) system to ensure foundational levels of competence for all students, staff, and faculty members in the School; and U of S will require all students entering the first-year program to complete an adaptive on-line course called *Pursuit of Reconciliation* before arriving on campus in September 2021, followed by an in-person module contextualizing the engineering profession within Indigenous worldviews, focusing on the impact of engineering projects on Indigenous communities, and the legal and moral requirements for consultation. In these plans, we see a resolute commitment to truth and reconciliation that speaks to the legal, moral,

social, and cultural responsibility we have to learn the truth about our colonial history and about the impact of colonization on Indigenous Peoples in Canada. In this way we can engage respectfully, reciprocally, and relationally [32] in reconciliation with First Nation, Métis, and Inuit Peoples. We argue that as engineering educators, we have a professional, ethical and social responsibility to train our future engineers, and faculty and staff in truth and reconciliation so that our new generation of engineers practice culturally safe, sensitive engineering [16] and demonstrate leadership in decolonization [20] and reconciliation.

5.1. Calls to Action

There were explicit references to Indigenous culture in engineering in some of the contributions. However, all institutions represented in this paper demonstrate commitment to bringing Indigenous ways of knowing and being into engineering education in responsible, reciprocal, respectful, and relational ways [32], and likely demonstrate and celebrate Indigenous culture in ways not explicitly recorded here. That being said, there are viable and sustainable initiatives institutions/organizations can adopt to acknowledge and respect Indigenous Peoples in Canada:

- Land acknowledgements – Acknowledgements of Treaty Territory, Unceded Territory, and the Metis homelands in course syllabi, classes, presentations, activities and events, and email signature lines
- Dedicated space for Indigenous students/faculty/staff
- Public artifacts demonstrating and celebrating Indigenous achievement, history, and culture, and explicitly acknowledge Indigenous students, staff and faculty in engineering education spaces
- Engagement in National Indigenous Peoples Day June 21 to celebrate the extraordinary diverse cultures and lives of First Nations, Métis and Inuit Peoples
- Engagement in Orange Shirt Day September 30 to explicitly acknowledge the intergenerational trauma perpetrated on Indigenous Peoples via Residential Schools and colonialism, and overtly demonstrate respect for Indigenous resistance and resilience
- Design teams/Capstone/projects with Indigenous initiatives – i.e., *Sustaining Engineering Challenger Design Team*, a multidisciplinary engineering design team redefining the way students think when working amongst different cultures and sensitivities (UBC)

5.2. Next steps

Some next steps for this project include:

- Hosting a virtual sharing circle for this work
- Continuing to update institutional contributions and connecting with institutions not represented here

- Plan a Sharing Circle with CEEA-ACEG 2021 conference organizers led by Mi'kmaw Elders and Peoples “who have lived in Mi'kma'ki, traditional Mi'kmaq territory, for at least 12,000 years” on the island known as “Epekwitk,” meaning ‘lying in the water’” [33]

6. CONCLUSION

This project is designed to build capacity in our CEEA-ACEG community to increase Indigenous representation, achievement, partnership and belonging in engineering and enhance engineering education across Canada. We are mindful that this work must be done in partnership with Indigenous Peoples and non-Indigenous people, and in recognition of the rights of Indigenous Peoples to self-determination and empowerment. Indigenous initiatives in engineering education have started in diverse ways and are at different stages of development in creating an ethical space in CEAB accredited engineering programs across Canada. In order to advance this work, it is critical to learn about the initiatives that are taking/have taken root in engineering education across the country, and build bridges and foster relationships and shared communities among our diverse Indigenous and non-Indigenous communities.

Acknowledgements

We are grateful to Elder Albert Marshall of the Mi'kmaw Nation for sharing his Mi'kmaq Etuaptmumk teachings and supporting this project. We thank Donna Kahérakwas Goodleaf from the Kanien'kehaka (Mohawk) Nation for her time and review of this paper. We are thankful to the Elders of Treaty 7 and 8, and Andrea Delgado-Olson of the Ione Band of Miwok Indians for their guidance on the Sharing Circle. We are grateful to all our contributors for working with us to bring the Indigenous initiatives in their institutions to light, and to all the Elders and Knowledge Keepers supporting this work across Canada. We are grateful for all our team members, and our commitment to participatory and respectful engagement. We are grateful for CEEA-ACEG, and the opportunity to share this work.

References

- [1] “Indigenous Peoples in Engineering,” *Engineers Canada*, May 19, 2016.
<https://engineerscanada.ca/diversity/indigenous-peoples-in-engineering> (accessed May 15, 2020).
- [2] Truth and Reconciliation Commission of Canada, “Truth and Reconciliation Commission of Canada: Calls to Action,” Truth and Reconciliation Commission of Canada, 2015. Accessed: Apr. 23, 2020. [Online]. Available: http://nctr.ca/assets/reports/Calls_to_Action_English2.pdf.
- [3] W. Ermine, R. Sinclair, and B. Jeffery, *The Ethics of Research Involving Indigenous Peoples*, SK: Indigenous Peoples' Health Research Centre, 2004, 273 pp. doi: 10.13140/RG.2.2.23069.31200.

- [4] Cape Breton University, "Guiding Principles (Two Eyed Seeing) | Integrative Science." <http://www.integrativescience.ca/Principles/TwoEyedSeeing/> (accessed May 15, 2020).
- [5] L. Fontaine and Y. Chen, "Wiingashk: Sweet Grass – Braiding Ways into Inclusive Education," presented at the Workshop, Centre for the Advancement of Teaching and Learning, University of Manitoba., Nov. 13, 2018.
- [6] "Videos | Integrative Science." <http://www.integrativescience.ca/Media/Video/> (accessed May 15, 2020).
- [7] A. H. Maslow, "A Dynamic Theory of Human Motivation," in *Understanding Human Motivation.*, C. L. Stacey and M. DeMartino, Eds. Cleveland, OH: Howard Allen Publishers, 1958, pp. 26–47.
- [8] J. Hughes and K. Shmon, *Needs Assessment Guide for Métis Communities*. Ottawa, ON: National Aboriginal Health Organization-Métis Centre, 2005, 68 pp. Accessed: Feb. 13, 2020. [Online]. Available: <http://www.naho.ca/documents/metiscentre/english/MCNeedsAssessmentGuide-EditAug4-05FINALAug22.pdf>.
- [9] Gwenna Moss Centre for Teaching and Learning, "Incorporating Talking Circles in the Classroom," University of Saskatchewan.
- [10] R. Roberts and S. Calvez, "Sharing Circle Online," University of Saskatchewan, Gwenna Moss Centre for Teaching & Learning.
- [11] "Talking Circle: Fact Sheet," *Talking Together*. https://www.learnalberta.ca/content/aswt/talkingtogether/facilitated_talking_circle_fact_sheet.html (accessed May 16, 2020).
- [12] C. MacDonald, "Understanding participatory action research: A qualitative research methodology option," *Can. J. Action Res.*, vol. 13, no. 2, pp. 34–50, 2012, doi: 10.33524/cjar.v13i2.37.
- [13] A. Gillis and W. Jackson, *Research for Nurses: Methods and Interpretation*. Philadelphia, PA: F.A. Davis Co, 2002.
- [14] S. Scott, "Drawing on Indigenous ways of knowing: Reflections from a community evaluator," *Can. J. Program Eval.*, vol. 23, no. 2, pp. 73–92, 2010.
- [15] K. Chandna, M. Vine, S. Snelling, R. Harris, J. Smylie, and H. Manson, "Principles, approaches, and methods for evaluation in Indigenous contexts: A grey literature scoping review," *Can. J. Program Eval.*, vol. 34, no. 1, pp. 21–47, 2019.
- [16] P. T. Morelli and P. J. Mataira, "Indigenizing evaluation research: A long-awaited paradigm shift," *J. of Indigenous Voices in Social Work*, vol. 1, no. 2, pp. 1–12, 2010. Accessed: May 16, 2020. [Online]. Available: <http://scholarspace.manoa.hawaii.edu/handle/10125/18773>.
- [17] P. Robertson, M. Jorgensen, and C. Garrow, "Indigenizing evaluation research: How Lakota methodologies are helping 'raise the tipi' in the Oglala Sioux Nation," *Am. Indian Q.*, vol. 28, no. 3/4, pp. 499–526, 2004.
- [18] J. G. Grover, "Challenges in applying Indigenous evaluation practices in mainstream grant programs to Indigenous communities," *Can. J. Program Eval.*, vol. 23, no. 2, pp. 22–50, 2010.
- [19] F. Cram, "Lessons on decolonizing evaluation from Kaupapa Māori evaluation," *Can. J. Program Eval.*, vol. 30, no. 3, pp. 296–312, 2016.
- [20] H. Castleden, T. Garvin, and H. First Nation, "Modifying photovoice for community-based participatory Indigenous research," *Soc. Sci. Med.*, vol. 66, no. 6, pp. 1393–1405, Mar. 2008, doi: 10.1016/j.socscimed.2007.11.030.
- [21] M. Minkler, "Assessment/evaluation. Using participatory action research to build healthy communities," *Public Health Rep.*, vol. 115, no. 2, pp. 191–198, Mar. 2000, doi: 10.1093/phr/115.2.191.
- [22] I. MacColl, R. Cooper, M. Rittenbruch, and S. Viller, "Watching ourselves watching: Ethical issues in ethnographic action research," in *Proc. of OZCHI 2005*, Canberra, Australia, Nov. 2005, p. 5. [Online]. Available: <http://eprints.qut.edu.au/90140/1/p28-maccoll.pdf>.
- [23] J. M. Case and G. Light, "Emerging research methodologies in engineering education research," *J. Eng. Educ.*, vol. 100, no. 1, pp. 186–210, Jan. 2011, doi: 10.1002/j.2168-9830.2011.tb00008.x.
- [24] "Winnipeg's 100-year-old aqueduct has brought a century of hardship to Shoal Lake First Nation | CBC News," *CBC*, Jun. 02, 2019. <https://www.cbc.ca/news/canada/manitoba/winnipeg-aqueduct-shoal-lake-100-years-1.5152678> (accessed May 15, 2020).
- [25] "Without Indigenous consent for pipelines, more protests to be expected: experts," *Global News*. <https://globalnews.ca/news/6634179/indigenous-consent-pipeline-protests/> (accessed May 15, 2020).
- [26] "About accreditation," *Engineers Canada*, Apr. 08, 2014. <https://engineerscanada.ca/accreditation/about-accreditation> (accessed May 16, 2020).
- [27] "Indigenous Peoples' Access to Post-Secondary Engineering Programs | Engineers Canada." <https://engineerscanada.ca/reports/research/review-practice-consensus-indigenous-peoples-access-post-secondary-engineering-programs> (accessed May 15, 2020).
- [28] J. LaFrance, R. Nichols, and K. E. Kirkhart, "Culture writes the script: On the centrality of context in indigenous evaluation," *New Dir. Eval.*, vol. 2012, no. 135, pp. 59–74, Sep. 2012, doi: 10.1002/ev.20027.
- [29] L. T. Smith, "Researching in the margins issues for Māori researchers: A discussion paper," *Altern. Int. J. Indigenous Peoples*, vol. 2, no. 1, pp. 4–27, Sep. 2006, doi: 10.1177/117718010600200101.
- [30] J. Cornthassel, "Re-envisioning resurgence: Indigenous pathways to decolonization and sustainable self-determination," *Decolonization Indigenous Educ. Soc.*, vol. 1, no. 1, Sep. 2012, Accessed: May 17, 2020. [Online]. Available: <https://jps.library.utoronto.ca/index.php/des/article/view/18627>.
- [31] J. Seniuk Cicek, A. Mante, C. Geddert, and L. Fontaine, "Engineering education re-interpreted using the indigenous sacred hoop framework," in *Proc. of the 8th Research in Engineering Education Symposium: Translating Research into Practice (REES)*, Cape Town, ZA, Jul. 2019, p. 9.
- [32] V. J. Kirkness and R. Barnhardt, "First nations and higher education: the four r's--respect, relevance, reciprocity, responsibility," *J. Am. Indian Educ.*, vol. 30, no. 3, p. 1, May 1991.
- [33] Indigenous Canada, "Prince Edward Island." <https://indigenoustourism.ca/en/regions/prince-edward-island/> (accessed May 15, 2020).