

Strengthening our wings of equity to empower civil engineering students to navigate our challenging world: embedding environmental justice, sustainability science, equity, diversity and inclusion across an undergraduate program

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ABSTRACT: Civil engineers are charged with safeguarding public welfare, yet traditional curricula often separate technical design from questions of equity, environmental justice and sustainability. This case study describes a bottom-up, program-wide initiative in the Department of Civil Engineering at the University of Victoria (Canada) designed to embed equity-centred competencies across an accredited undergraduate curriculum. Framed through the metaphor of two complementary “wings”, technical excellence and equity-centred practice. We conceptualize equity as a design goal, an epistemological grounding that broadens whose knowledge counts, and a professional competency that can be explicitly developed and assessed. Between 2022 and 2024, faculty collaboratively developed 23 lecture modules and eight in-class activities integrated across required second- and third-year courses with extensions for first- and fourth-year courses. We describe the motivations, institutional context, development process, and three illustrative course examples in water resources, transportation engineering, and drinking water contaminants. Reflections highlight enabling conditions (institutional alignment, dedicated funding, faculty

40 **champions), tensions (time constraints, resistance, balancing technical and equity content), and lessons**
41 **learned about mainstreaming equity within required courses. We argue that embedding equity, rather than**
42 **appending it, strengthens accreditation-aligned graduate attributes, enhances student engagement, and**
43 **better prepares graduates for the realities of contemporary civil engineering practice. This case offers**
44 **transferable questions and practical strategies for departments seeking to integrate equity-centred**
45 **approaches at the program scale.**

46

47 **1. Why equity is important for civil engineering education**

48

49 A paramount responsibility of all engineers is to work in the interest of the public good, which includes the
50 safeguarding of human life, welfare, and the environment (ASCE 2020; Engineering Council and Royal Academy
51 of Engineering 2017; Engineers Canada 2024; Engineers Europe 2022; NSPE 2019). Professional body guidelines
52 and codes of ethics across jurisdictions increasingly relate this responsibility, in explicit terms, to sustainability,
53 environmental justice, and equity, diversity, and inclusion (EGBC 2021; Engineers Canada 2016). The urgent
54 challenges of climate change, global biodiversity loss, water scarcity, racial injustice, geopolitical upheaval, and
55 widening social inequalities (UNESCO 2021) collectively highlight and call for a greater recognition of the
56 connections between engineering, sustainability, and equity and the expanded competencies these connections
57 require engineers to hold. As a service-based profession, civil engineering competencies are dynamic and must
58 continuously evolve in response to catalytic events and changing societal needs. The global uprisings against anti-
59 Black racism forced many institutions, including our own, to confront systemic injustices in their practices. In
60 Canada, the identification of potential unmarked burial sites at former Indian Residential Schools renewed urgency
61 around Indigenous reconciliation and underscored the necessity for engineers to understand their work in relation
62 to Indigenous sovereignty. Additionally, the global resurgence of right-wing populism has politicised discourse on
63 equity, science and climate, reinforcing the value in framing equity competencies and concepts as essential, future-
64 proof professional skills for today and the uncertain future.

65

66 These challenges are not external to engineering but are the contextual realities shaping and interacting with the
67 systems that civil engineers design, build, and maintain. The role of the engineer and their work is not neutral or
68 apolitical. Civil engineering history is filled with technically excellent and often well-intentioned designs that
69 dominate nature, lands and peoples, contributing to inequitable and/or unsustainable outcomes (Winner 1980).
70 These range from pollution control facilities installed near marginalized communities (Bullard 1990, 1993; Waldron
71 2020), the construction of hydropower dams that have displaced Indigenous Peoples and submerged Indigenous
72 territories, including sacred sites (Larsen and Johnson 2017), the prioritization of car-centric infrastructure that
73 privileges wealthy suburban commuting over transit-dependent and pedestrian communities (Deboosere and El-
74 Geneidy 2018), and the practice of redlining to support freeway construction through minority neighbourhoods that
75 spatially confines poverty (Schell et al. 2020). Additionally, discrimination and exclusion persist within engineering
76 education and practice, with well-documented patterns of marginalization related to gender, race, Indigeneity,
77 disability, and socioeconomic background, often operating through informal cultures, epistemic norms, and
78 institutional structures rather than overt bias alone (Faulkner 2007; McGee 2016).

79

80 Equity in social justice generally refers to the fair and just distribution of resources, opportunities, and treatment,
81 recognizing that different communities have different needs and historical circumstances (Braveman and Gruskin
82 2003; National Academies of Sciences and Medicine 2017). In this initiative, we understood and framed equity as
83 a broad and essential competency that is foundational to environmental justice and sustainability and contributes to

84 the framework of equity, diversity and inclusion (EDI or DEI). Yet, each of these domains has its own literature,
85 history, and motivations that we do not seek to diminish or flatten; other initiatives could use different organizing
86 themes or terms to connect these topics. *Environmental justice* (EJ) originates from Black communities protesting
87 racist environmental practices, and is defined as the fair treatment and meaningful involvement of all people
88 regardless of race, color, national origin, or income with respect to the development, implementation and
89 enforcement of environmental laws, regulations and policies (Bullard 1990). *Sustainability science* (SustSci) most
90 commonly traces its foundations to the Brundtland Commission's definition of sustainability development (WCED
91 1987), defined as “development that meets the needs of the present without compromising the ability of future
92 generations to meet their own needs”. Sustainability is thus fundamentally grounded in the principles of
93 intergenerational and intragenerational equity (Jerneck et al. 2011). *Equity, diversity, and inclusion* (EDI) is
94 important in various institutional contexts; for example, the Natural Sciences and Engineering Research Council of
95 Canada (Government of Canada 2025) provides useful working definitions of EDI relevant for engineering: “equity
96 considers people's unique experiences and differing situations, and ensures they have access to the resources and
97 opportunities that are necessary for them to attain just outcomes; diversity describes the presence of a wide range
98 of human qualities and attributes within a group, organization or society; inclusion is the practice of proactive
99 measures to create an environment where people feel welcomed, respected and valued, and to foster a sense of
100 belonging and engagement.”

101
102 The curriculum initiative described in this paper centres and elevates equity as a broad and essential competency
103 which is consistent and aligned with broader movements in engineering education. Individual courses (Mitchell et
104 al. 2019; Oulton et al. 2021), broader program-level reforms (Chau 2007; Nelson 2025; Sinnott and Thomas 2012;
105 Wolf et al. 2022), and myriad theoretical frameworks and guidelines (Bielefeldt et al. 2020; Catalano 2020; Eastman
106 et al. 2019; Fenner et al. 2014; Quelhas et al. 2019; VanderSteen 2008) have sought to implement sustainability,
107 environmental justice, and EDI within undergraduate engineering programmes across institutions in Brazil, Canada,
108 Hong Kong, Ireland, United Kingdom, and the United States. These priorities are reinforced in engineering
109 accreditation; for example, in Canada, two related attributes that every graduating student is meant to learn are
110 ‘impact of engineering on society and the environment’ and ‘ethics and equity’. This work is further motivated by
111 broader institutional support as institutions such as UNESCO, the Canadian Academy of Engineering, and
112 Engineering Deans Canada have called for more interdisciplinary and socially responsive training for engineers
113 (Engineering Deans Canada 2022; UNESCO 2021). The American Society of Civil Engineering has several aligned
114 initiatives, including MOSAIC (Members of Society Advancing an Inclusive Culture) and ASCE’s Committee on
115 Sustainability. A related priority is diversity, and Engineers Canada has recently adopted a quantifiable goal posed
116 by the Government of Canada. This ‘50-30 challenge’ calls for reaching 50% gender parity in all boards and senior
117 positions and aspires to reach 30% inclusion of other under-represented groups¹ on boards and senior positions
118 (Engineers Canada 2021). These sample initiatives illustrate a broader movement towards integrating equity within
119 engineering education, and are not meant to be comprehensive. Many exist and several are internal initiatives and
120 are inward facing.

121
122 Our program-wide, collaborative, and bottom-up initiative is novel in that it extends beyond a single course without
123 a top-down mandate. This “Learn and Teach Green, People-centred Civil Engineering” initiative at University of

¹ Racialized individuals, Black Peoples, People with disabilities (including invisible and episodic disabilities), 2SLGBTQIA+ and/or gender and sexually diverse individuals, and Indigenous Peoples. The program and participants recognize First Nation Peoples, Métis Nation, and Inuit as founding Peoples of Canada and are underrepresented in positions of economic influence and leadership.

124 Victoria (Canada) aimed to embed rather than append equity-centred approaches across the whole program, frame
125 equity as a core rather than supplemental competency, and connect equity-centred competencies and graduate
126 attributes in our accreditation process (see **Supplementary Information**). We argue below that these equity-centred
127 competencies, goals and knowledge systems are essential to civil engineering, and complementary to the technical
128 curriculum (**Section 2.1**). We express these essential, complementary aspects of civil engineering with the visual
129 metaphor of two wings of a bird (**Figure 1**), with every engineering student being a flying bird that is trained and
130 nurtured in a nest, representing the curriculum (**Figure 2**).

131
132 **Our objective in describing this initiative is to inform, enable, or inspire similar work by documenting our**
133 **motivations, conceptual framings, curriculum development process and outcomes, and reflections on lessons**
134 **learned through this process.** We acknowledge that every instructor, department, and institution is unique and we
135 do not suggest those in different contexts could or should use our methods, arguments or outcomes directly like a
136 reproducible, step-by-step strategy. Rather, we offer these approaches, outcomes and reflections for wider
137 consideration from our experience with our initiative, which took place primarily between 2022-2024 in our specific
138 Canadian institutional context (**Section 2.2**). We invite readers to start or keep following their own strategies that
139 are respectful and useful in their context.

140
141 We note a few important and relevant considerations to contextualize this work. We have specific experiences and
142 social locations (**Section 2.3**) that enrich, shape and potentially bias our work. Different dominant and marginalized
143 identities intersect, and herein some identities might seem flattened or oversimplified or inadequately emphasized.
144 We acknowledge this and encourage readers to expand on these ideas as appropriate to your context. Teaching in
145 the context of the Canadian settler state with our varied social locations, we also reflected significantly on how to
146 respectfully incorporate Indigenous issues and priorities, Truth & Reconciliation (T&R), and Indigenous
147 approaches to engineering (Cicek et al. 2023). From Indigenous team members and advisors, we are conscious of
148 the importance of differentiating T&R and EDI work due to the distinct colonial legacies and ongoing
149 marginalization; herein we do not explicitly differentiate between T&R and EDI work but return to this in **Section**
150 **5** (reflections and lessons learned).

151 152 **2. Multiple contexts of our initiative: discipline, institutions and team**

153
154 Since context is integral to equity, we introduce the multiple contexts of this initiative: in our discipline (Section
155 2.1), in our institutions (Section 2.2) and in our team (Section 2.3).

156 157 **2.1 Equity in the context of civil engineering education**

158
159 In our initiative, we consider equity as a design goal, professional competency, *and* as an epistemological foundation
160 that challenges dominant ways of knowing in engineering (Baillie 2009; Cech 2014; Leydens and Lucena 2017;
161 Riley 2008). This invites students and educators to question who defines engineering problems, whose knowledge
162 is valued, and what kinds of futures are imagined and rendered possible through our designs. Each of those three
163 different equity-centred aspects are illustrated in two ways: first with a general example from civil engineering
164 curriculum development, and then with a specific example from a water resource engineering course.

- 165 1. ‘Equity as a goal’ is the most common framing, especially in public policy and professional ethics: equity
166 is what we are working toward. Students learn to design infrastructure that is sustainable and doesn’t

167 disproportionately harm marginalized communities. For example, a student design project that evaluates
168 whether a stormwater green infrastructure plan reduces flooding inequities between low-income and high-
169 income neighborhoods.

- 170 2. ‘Equity in knowledge systems’ (or epistemological grounding) highlights that equity shapes what is
171 considered valid knowledge, who is seen as a knowledge holder, and how problems are framed in the first
172 place. This is the deepest level, and often the most under-examined in engineering. It means recognizing
173 that traditional engineering knowledge systems have been shaped by Eurocentric, male-dominated,
174 technocratic perspectives (Harding 1998; Mejia and Christiansen 2024) and that equity requires questioning
175 those assumptions. Students reflect on how engineering prioritizes ‘neutral’ technical knowledge over
176 experiential, community, or Indigenous knowledges while asking whose knowledge counts or who gets to
177 define problems and solutions. For example, instead of just asking “how can we model flood risk?” we also
178 ask “whose lands are we modeling? What are the colonial histories of these ‘risk zones’? Who was excluded
179 from defining the problem?”.
- 180 3. ‘Equity as a competency’ (or skill set or tool) is the most pragmatic and curricular, and treats equity as
181 something engineers should be able to apply in their professional practice. Students can develop equity-
182 related skills that encourage them to understand equity as an ongoing process, not just an end goal. These
183 skills can be clearly defined as learning outcomes and practiced through class activities and modules. For
184 example, students in a flood risk term project apply anti-oppression frameworks for team dynamics, and
185 then conduct stakeholder analysis that includes sustainability and racial equity lenses, or use storytelling
186 and lived experience as part of problem scoping.

187
188 Instead of naïvely integrating, combining or blending environmental justice, sustainability science and equity,
189 diversity and inclusion (EDI or DEI), we instead try to introduce and contextualize each individually, while also
190 acknowledging potential friction points between different approaches. Diversity and inclusion are essential
191 conditions that enable equitable engineering practice, but equity provides the analytical lens for examining power,
192 historical context, and the distribution of risks and benefits. Rather than treating EDI as a parallel domain, we
193 situate it within an equity-centred approach that emphasizes outcomes, knowledge systems, and professional
194 responsibility. While imperfect, we found this framing enabled a wide array of entry points among course
195 instructors to engage with our curriculum initiative. This framing of equity-centred approaches, along with the
196 bird/nest metaphor, have strengths and limitations that we further discuss in the **Supplementary Information**.

197
198 To visualize our understanding of equity-centred and technical-centred competencies as two essential,
199 complementary aspects of civil engineering, we developed the visual metaphor of these competencies as wings of
200 a blue heron to bring our initiative to life (**Figure 1**). In this metaphor, the heron represents the students progressing
201 through the UVic CIVE programme. We selected the blue heron as these beautiful birds are often visible on nearby
202 beaches of the campus where we led this initiative (UVic), which sits on the territories of the Lək̓ʷəŋən (Songhees
203 and X̱wəpsə̱m/Esquimalt) Peoples (also known as Victoria, British Columbia, Canada). This inspiring place guides
204 our understanding on the relationship between equity-centred and technically-centred engineering. **Table 1**
205 summarizes these three aspects of equity-centred goals, knowledge systems and competencies in contrast to
206 technically-centred approaches (represented by the other wing of the bird) that have been described at length
207 elsewhere (National Academy of Engineering 2004).

208

209 Blue herons lurch into flight with an awkward effort. Gangly legs scrambling for lift, wings flapping in broad,
210 labored sweeps. Yet, within moments, awkwardness gives way to grace as it glides, silently and elegantly, over the
211 water. Similarly, students and instructors can be awkward and find lift-off challenging when starting this work. We
212 found in practice that this awkwardness relatively quickly morphs into gliding (and then occasional headwinds or
213 other challenges!). The idea of balance crosses many metaphors, stories and teaching. This metaphor articulates our
214 understanding that technical engineering skills and equity skills are equally important and essential for students ‘to
215 fly’ in their careers of service. Herons build nests over multiple years and often nest in large colonies called
216 rookeries. We can extend the metaphor to consider the entire undergraduate program as the nest that students
217 iteratively loop out from in their individual learning journeys in courses and co-op work terms (**Figure 2**). We
218 importantly note that because these concepts were already introduced in some form before our initiative, we do not
219 wish to insinuate that students and alumni of our program and from other schools are not ‘flying’. Rather, our hope
220 through systematically embedding equity across the program was to enable a ‘soaring’ of students already in flight.

221

222 **2.2 Institutional contexts of the university, department and professional body**

223

224 Sustainability, anti-racism, justice and EDI are mainstreamed priorities across the multiple institutional contexts of
225 our undergraduate program (university, department and professional body). UVic has strengths and priorities in
226 addressing environmental and social challenges. The current strategic plan (University of Victoria 2023a) has three
227 relevant priority areas: ‘people, places and the planet’ addressing sustainability, climate action and the systemic
228 barriers affecting equity, diversity and inclusion; ‘change and transformation’ re-imagining what we do, how we do
229 it and why; and ‘Indigenous perspectives’ prioritizing the rights of all humans and more-than-humans. The
230 University also has specific related priorities in the research strategy (University of Victoria 2021), Equity Action
231 Plan and Indigenous Plan (University of Victoria 2023b). Our curriculum development was supported by the Anti-
232 Racism Initiative grant from the Learning and Teaching Innovation (LTI) centre. This grant supports learning and
233 teaching projects aligned with UVic’s commitment to anti-racism and the values of equity, diversity, inclusion, and
234 belonging, enabling us to hire specific research assistants to support the development of course material.

235

236 The Department of Civil Engineering (CIVE) is a relatively new department (established in 2016; first graduating
237 class in 2017) with a vision of being Canada’s greenest civil engineering department. Our mission is addressing
238 the most pressing global environmental and sustainability challenges by working for and with a diversity of
239 people on the diverse technologies that build society. The Department defines green civil engineering as
240 managing, designing, constructing and maintaining the built and natural environment, using technologies and
241 techniques that provide services to society, while working within the carrying capacity of local ecosystems and
242 the planet. This teaching initiative is inspired by this vision and contributes to all four of the missions of the
243 department: the technology that builds society; deep green engineering; engineering for & with people; and
244 learning with heads, hands and hearts. The faculty have teaching and research strengths across industrial
245 metabolism, green chemistry, water and wastewater treatment, building energy use, project and construction
246 management, sustainable construction technologies and materials, renewable energy transformations, energy
247 systems integration, and air quality.

248

249 Our accredited undergraduate program has all the courses and aspects of traditional civil engineering with specific
250 design-centred courses and four mandatory co-operative education (‘co-op’) terms where students gain valuable
251 professional experience through work placements. First year coursework is common across all engineering
252 programs; second year and third year are primarily required civil engineering courses; and fourth year has a design

253 capstone project and technical electives. The program does not have formal specialization streams so students take
254 all the same required courses but can self-specialize through technical electives, capstone projects and co-op
255 placements. Before this initiative, equity-centred content was included in a few courses, such as the first year course
256 ‘Introduction to Professional Practice’, second year course ‘Sustainability in Civil Engineering’, third year course
257 in ‘Environmental Policy’ and fourth year electives including ‘Infrastructure Engineering for Indigenous
258 Communities’ and ‘Resilient Smart Cities’. This equity-centred content generally emphasized sustainability science
259 concepts, but core concepts in environmental justice and equity, diversity and inclusion were underrepresented.
260 Equity-centred content was introduced on a piecemeal, course-by-course basis without deep integration or
261 coordination between instructors or syllabi. When discussing specific courses below, general engineering (ENGR)
262 and civil engineering (CIVE) courses are numbered based on their year from first year (CIVE 1XX) to fourth year
263 (4XX).

264
265 Equity, ethics, and professionalism are integrated across the engineering co-op program through both coursework
266 and applied workplace learning. Students are introduced to equity, diversity, and inclusion (EDI) concepts in
267 ENGR 130 (Introduction to Professional Practice), which addresses intersectionality, equity versus equality,
268 universal design, professional ethics and codes of conduct, bias in algorithms, cultural differences in design and
269 decision-making, human rights obligations, and standards of professional behaviour, alongside information on
270 institutional supports and cultural intelligence competencies. These themes are reinforced and extended through
271 the co-op work-term courses (ENGR 001–004) where students complete structured competency-based
272 assignments involving goal setting, mid-term reflection, and final evaluation with employer feedback. Across
273 work terms, students engage with graduate attributes related to professionalism, ethics, diversity and equity,
274 societal and environmental impacts, communication, teamwork, and lifelong learning, and may choose to
275 explicitly develop cultural intelligence competencies through their workplace experiences. Together, these
276 elements ensure that students encounter equity-related concepts both in classroom settings and in real-world
277 engineering practice.

278
279 Our program and most individual instructors are accredited by Engineers and Geoscientists British Columbia
280 (EGBC) which has taken a multifaceted approach to advancing Equity, Diversity, and Inclusion (EDI), anti-
281 racism, Truth and Reconciliation, and sustainability within the engineering and geoscience professions. EGBC’s
282 EDI efforts are anchored by professional practice guidelines that clearly outline registrants’ obligations under the
283 Professional Governance Act and Code of Ethics, and include the *Guide to Inclusive Practices* (EGBC 2023),
284 which offers practical tools for inclusive communication, meeting facilitation, and land acknowledgments. In
285 terms of anti-racism, EGBC has hosted a series of public webinars, including a notable five-part series addressing
286 systemic issues and a focused session on anti-Black racism in the professions. EGBC’s commitments to Truth and
287 Reconciliation include promoting Indigenous language visibility in professional contexts, supporting culturally
288 safe engineering practices, and providing education on intercultural competency and Indigenous rights. On the
289 sustainability front, EGBC has integrated climate responsibility into its Code of Ethics and issued an updated
290 *Climate Change Position Statement* and *Sustainability Guidelines*, emphasizing the duty of registrants to consider
291 environmental impacts in all stages of engineering and geoscience work. Together, these initiatives reflect
292 EGBC’s growing emphasis on ethical responsibility, justice, and long-term resilience in professional practice.

293 **2.3 Our team context: who’s doing the work, what motivates them and what they’ve learned**

294

295 Our team members' varied social locations and educational training are relevant contexts that shaped the project.
296 We share these here along with our individual intentions and reflections. Hampton et al. (2021) argue that
297 discussions of researcher positionality are useful in engineering education research to provide context in the
298 production of knowledge as well as bolster research transparency and the community's trust in the work. The
299 initiative was led overall by white, cis-male settlers with engineering and other quantitative skills training. The
300 broader team and initiative advisers were more diverse in educational training and represent multiple identities of
301 race, gender, and sexual orientation. Collectively, these show diverse experiences and social locations that
302 supported the curriculum development, implementation and teaching. In the final 'reflections and lessons learned'
303 section we synthesize and reflect overall on our individual social location, intentions and reflections.
304

305 Chinchu: I am originally from Kerala, a southern state in India, and have been living in Canada for the last 5 years.
306 I have a background in groundwater hydrology, risk assessment, and climate change adaptation. Growing up near
307 rivers and coastlines shaped my deep connection to water and climate, and witnessing the growing impacts of
308 climate change in my community sparked a commitment to work on just and equitable responses to environmental
309 challenges. I joined this initiative because I believe technical education must confront the realities of environmental
310 injustice and prepare us to act with care, humility, and accountability. One of the most powerful lessons for me has
311 been seeing how students respond when given space to name injustice and connect it to their engineering or
312 scientific work. It reminded me of my own journey- how transformative it was to realize that my voice, experiences,
313 and values belong in these conversations too.
314

315 Crystal Ng (she/her): I am a second-generation Chinese-American. In addition to identifying as the daughter of
316 immigrants, I currently live and work as a settler on Dakota and Ojibwe homelands in present-day Minnesota.
317 Although I now conduct hydrology research at University of Minnesota in collaboration with Tribal partners, my
318 earlier work failed to adequately engage them and thus perpetuated harms that western science has inflicted on
319 Indigenous Peoples and their waters. The humbling lessons I've learned around my mistakes motivate me to
320 incorporate Indigenous perspectives and issues into teaching—to support a next generation of better scientists. My
321 involvement in this UVic initiative helped me see what we can collectively learn and do when we share ideas across
322 locations and institutions.
323

324 Heather (she/her): I am a white, cisgendered woman of Scottish/Irish/English/Welsh ancestry, born on Treaty 7 and
325 Métis Nation of Alberta Territory, and proud Auntie of a Métis toddler who loves to dance and is already an
326 engineer. I teach and research at the intersection of water engineering and green chemistry; the design of systems
327 and processes to empower communities and reduce harm across the lifecycle is at the core of our work. Bringing
328 environmental justice explicitly to the forefront, and empowering students with tools and skills to act in their
329 professional and personal contexts on the idealism that brings many of them into our classroom motivates my work
330 in this initiative. I am inspired by learning repeatedly that everyone has a water story; when students can choose
331 projects based in their own lived experiences they connect deeply with the material and the other human experiences
332 that weren't part of their original stories.
333

334 Kamilla (she/her): I am a biracial settler born and raised in Canada on the territory of the Haida Nation and Syilx
335 Nation. I have experienced minority stress as a cis-gendered woman and racialized individual and have worked in
336 equity and human rights in community and at universities for about 20 years. I was eager to join this initiative in
337 recognition both of engineering's significant, long-term impacts on the environment and humans and appreciation
338 for the depth of transformation this initiative is aiming to achieve. My experiences in Canada and abroad have

339 shown me the importance of talking about the power structures and norms of inclusion and exclusion that shape
340 academic institutions and research contexts so that we can reshape them for equity and inclusion.

341 Laura (she/her): I am originally from France and have called Canada home since 2014. As a cisgender woman in
342 engineering, I've encountered subtle, often indirect forms of bias that can gradually erode both professional
343 confidence and one's feeling of legitimacy within the field. With expertise in transportation and air quality, my
344 work focuses on assessing population exposure to air pollution. I joined this initiative because environmental
345 challenges—whether related to transportation systems or air quality —do not recognize boundaries, yet their
346 impacts are unevenly felt. A key lesson from this initiative is how engaged students are when issues of inequity and
347 environmental injustices are introduced, highlighting the need to fully integrate them into engineering education
348 rather than treating them as secondary topics.

349
350 Luiz: I am a Black Brazilian Indigenous person, and Canada has been my home since 2020. My research and
351 professional work focus on developing water and wastewater treatment technologies that are sustainable, equitable,
352 and rooted in marginalized and remote community needs. Growing up in a favela in Rio de Janeiro, where access
353 to clean water was limited and life expectancy low, I witnessed firsthand the deep consequences of environmental
354 injustice. I joined this initiative because I saw it as a pathway to create meaningful solutions to some of the world's
355 most urgent challenges, water scarcity, climate change, and environmental injustice. One key lesson from this
356 initiative has been realizing how even small changes, like introducing environmental justice and anti-racism
357 concepts early in engineering courses, can significantly shape how students approach design, leading to more
358 inclusive and socially responsive engineering solutions. Sometimes, big changes begin with small ones.

359
360 Mami: I was born and raised in Japan and came to Canada as an international student before becoming an immigrant.
361 As a racialized, heterosexual, cisgender, able-bodied woman who learned English as an additional language, I carry
362 lived experience of marginalization while also recognizing the privileges I hold in different spaces. Grounded in
363 both my education and professional background, I am committed to helping organizations, units, and communities
364 build environments where diverse members can thrive without feeling the need to conceal any part of their identities.
365 I am motivated by the opportunity to contribute to this initiative that supports the next generation in developing the
366 capacity to build a more equitable and inclusive future. This work is our collective responsibility. It is never “one-
367 size-fits-all.” It requires flexibility, humility, and responsiveness to both visible and invisible barriers.

368
369 Noella: I am Cold Lake Cree First Nation on my mother's side and a part of the Romani diaspora, specifically Sinti
370 and Manoushe, on my father's. I was born and raised in the Yukon on the shared territories of the Kwanlin Dunn
371 and Ta'an Kwachan First Nations, but have been an invited guest on the unceded lands of the Lekungen speaking
372 peoples for more than 5 years now, since moving down to attend UVic. In my undergrad I completed a double
373 major in Psychology and Indigenous studies with a focus on community wellness and the revitalization of
374 Indigenous health practices. I have been lending my knowledge and my voice to this initiative since its inception in
375 order to help us be grounded and move forward in a good way, with humility and curiosity.

376
377 Rishi: I was born and raised in the western part of India where I completed a diploma in Civil Engineering and
378 subsequently a Bachelors degree in Civil Engineering as well. I immigrated to Canada close to three decades ago
379 and identify myself as a person of colour. A registered engineer with industry and academic experiences in India
380 and Canada, I have lived experience that has exposed me to challenges a person of colour faces in the profession.
381 I have a decade of experience in the field of EDI. I have served on the EDI committee of the University for several

382 years, served as the special advisor to the Dean on EDI, served on the 30x30 champions group of EGBC, and now
383 serve on the CEQB of Engineers Canada where I am co chairing the 50-30 sub committee. I continue to witness
384 lack of understanding of the principles in the profession and I hope to contribute to this initiative by making a
385 change not just in curriculum but also in professional practice.

386
387 Summer: I am an Indigenous Igbo woman from Nigeria, I moved to Canada in 2020 for my Masters, and currently
388 a doctoral researcher at UVic. My research focuses on Environmental injustice, climate change, Indigenous rights
389 and energy extraction and exploitation. My social location is entangled with questions of extraction of lands, of
390 voice, of power and with the quiet urgency of restoration. I carry the tension between legal formality and human
391 reality. I was called to this initiative because of my experience in Environmental justice, anti-racism, and Indigenous
392 governance. A moment that stays with me: a student who whispered, “I never knew I could say that here,” after
393 naming racism in an energy policy class. This initiative, for me, is about making that “here” bigger.

394
395 Thomas: I am of a family of European religious minorities who were repeatedly driven out of their homelands to
396 become settlers in Western Canada. I have deep roots in the Pacific West Coast that ground me in appreciation and
397 respect for the Indigenous peoples of these lands; and an engineer’s calling to build solutions that serve society,
398 grounded in the humility of offering but one voice within a diverse chorus; and of a dedication to work against the
399 injustice in our societies’ draw upon the environmental well-being of our children.

400
401 Tom: I have a mixed European settler background (German, Irish and Ukrainian). My groundwater-focused
402 research and teaching are driven by my academic background in geoscience and engineering combined with an
403 abiding passion to do something useful for people and the planet. I was called to this initiative by my growing
404 awareness of environmental justice, and how critical yet under-represented this is in technical education. The most
405 impactful of many learnings was how important teaching this content is (based on reflections of multiple students).

406
407 Xander: I am a white settler of European descent, trained as an engineer and now working as a global groundwater
408 scientist. I grew up along the Nonquon River, with which I first formed a relationship with freshwater, not knowing
409 then that its flow had been profoundly altered by 19th century dams that flooded traditional wild rice harvesting
410 areas of the Mississaugas of Scugog Island First Nation. My current work often involves global datasets and
411 conceptual models, and that I often find disconnected from the lived realities of those most impacted by water
412 injustice. Motivating my participation in this initiative is to help reconcile a dissonance I perceived during my
413 formal engineering training, where I felt the “human” was taught out of the engineer, yet I had always wanted to
414 lead/contribute to work that felt aligned with my personal values. One lesson from this initiative has been that
415 applied, in-class breakout activities that invite students to connect technical work with ethics and lived experiences
416 are far more impactful than rote lectures on sustainability and justice theory, methods, and key concepts.

417 418 **3. Process of curriculum development**

419 Curriculum was developed in this bottom-up initiative in three separate but complementary interconnected projects:
420 1) environmental justice, environmental racism and anti-racism practices for groundwater hydrologists; 2)
421 embedding anti-racism, environmental justice and sustainability science across the CIVE program; and 3)
422 transportation accessibility and equity, environmental justice and anti-racism practices for transportation engineers.
423 The first and third projects focused on individual courses (CIVE 445 Groundwater Hydrology and CIVE 360
424 Sustainable Transportation Systems, respectively) while the second project worked across the whole program.

425 As described above, sustainability content was already in various courses, but environmental justice and anti-racism
426 curriculum development started in the spring of 2022 with a single 4th year course (groundwater hydrology). This
427 curriculum development was inspired by a hydrogeology field course at University of Minnesota in the previous
428 year. The instructor team, led by Crystal Ng and with Tribal, law, and environmental agency collaborators, had
429 developed content around legal and ethical obligations on Indigenous lands, with a final student project examining
430 the environmental injustices and groundwater threats from oil pipelines for Tribal communities (Ng et al. 2020).
431 With funding from the Anti-racism Initiative at UVic we assembled a diverse, multi-institutional project team and
432 advisors group with expertise and lived experience especially in environmental racism and justice. Adding to our
433 team from UVic and University of Minnesota, we hired two dedicated research assistants, with preferential hires
434 for Black, Indigenous or People of Colour students. We met weekly and started with a multi-week co-learning
435 exercise where we discussed groundwater hydrology, Indigenous studies, and environmental justice to create a
436 common language and understanding. Then we conducted a multi-week horizon scan of case studies and previous
437 teaching materials on groundwater-related environmental racism and injustice. Then we were ready to design and
438 develop the teaching materials, described below, which were reviewed and improved by a series of expert advisors:
439 Ryan Emanuel (environmental justice and Indigenous water), Ingrid Waldron (environmental racism), Deb Perrone
440 (environmental justice and groundwater), Pamela Wolf (decolonizing engineering) and Gilles Wendling
441 (hydrogeology and environmental law), as well as UVic advisors Kristian Dubrawski and Crystal Tremblay
442 (community based research). This content was first developed and delivered for a limited enrollment, 4th year
443 elective in groundwater hydrology but we quickly realised it would be much more impactful and appropriate to
444 migrate content to a required 3rd year class in Sustainable water resources. This process solidified our knowledge
445 of this content and how to potentially deliver it, as well as our confidence in the importance of this work, and the
446 need for it across the curriculum.

447
448 Inspired by the first project, we also proposed a cross-department effort in the spring of 2022, to embed this content
449 across the whole undergraduate program, to show leadership in sustainability, EDI and environmental justice while
450 also possibly simplifying accreditation (Supplementary Information). We offered, to individual faculty, that any
451 instructor could improve their course to better include equity-centric content with minimal effort. We see curriculum
452 development as making change for and through students. Therefore, we focused on change-makers, ensuring that
453 this program was voluntary and opt-in rather than compulsory. The project was supported by Tom Gleeson's
454 President's Chair funding that supported a part-time curriculum development position for doctoral student Xander
455 Huggins. We strategically kept the initiative informal and responsive while keeping our departmental leadership
456 and curriculum committee informed and involved. In this way, our initiative highlights an alternative model that is
457 not mandated, driven or led directly by departmental leadership or curriculum committee. As a first step, in February
458 2022, we surveyed interested colleagues with the following questions:

- 459
- 460 ● What course are you interested in modifying?
 - 461 ● What do you find most exciting about this course? What do you find most challenging about this course?
 - 462 ● What type of content are you interested in adding? EDI, anti-racism, sustainability, and/or environmental
463 justice/racism
 - 464 ● Do you have an idea of what unit/module/topic or assignment/project you might want to modify? If so
describe in 50 words and ideally add link to pdf

465 At first we engaged with any interested faculty but soon focused generally on 2nd and 3rd year required courses since
466 we have limited control over common 1st year courses, and as 4th year courses are mostly electives. Further,
467 mainstreaming this content in required courses ensured all students in the program would be introduced to equity-

468 centred competencies, goals, and knowledge systems. Mainstreaming this equity-centred curriculum is not an
469 incidental choice, and can seed resistance and pushback from colleagues and students (see **Section 5.1**), especially
470 in a period where many of these terms have become associated with politicised public discourse. Yet, we found it
471 more compelling and enduring to address the prevailing culture of disengagement in engineering education (Cech
472 2014), where social and political considerations are often deemed outside of the scope of professional engineering
473 practice, thus undermining the ability of engineers to fulfill their legal and professional responsibilities to public
474 welfare.

475 Overall, we started an interactive ‘looping’ engagement with interested departmental faculty, moving from the
476 courses where it was most readily integrated to those where integration was more uncertain. Each loop would consist
477 of: individualised request for engagement, review of current course content, identification of areas for addition or
478 modification, curriculum development, integration into next course offering. We generally had an ~1 hour meeting
479 to discuss benefits/opportunities with individual faculty, leading to tailored, pragmatic course-level improvements
480 but with the overall scope/coordination by initiative leads. During this meeting we reviewed their answers to the
481 survey questions and then asked deeper, probing questions like:

- 482 ● Do you have a vision / idea for a new module?
- 483 ● How could your course build a student’s conceptual understanding of sustainability?
- 484 ● How could your course build the student’s practice of EDI and anti-racism, integrate EDI as professional
485 practice and/or develop awareness of environmental racism in engineering?

486 Xander would then develop the new course content in consultation with the course instructor, place new content in
487 the broader initiative, and add to the compendium of resources for sharing. By the fall of 2022, we had developed
488 content across six courses, and written preliminary program-level learning objectives. At a departmental retreat, we
489 shared the new content, compiled existing content from other courses and confirmed that our program-level learning
490 objectives were consistent with departmental culture.

491 Then in 2022, Laura Minet led a follow-on project also funded by the UVic Anti-Racism Initiative on transportation
492 accessibility and equity, environmental justice and anti-racism practices for transportation engineers. The project
493 included the hiring of research assistants through a preferential hiring process, including one RA from another
494 institution with a background in sustainable urban planning and personal experience as a newcomer from Southeast
495 Asia. The course CIVE360 serves as UVic civil engineering students' first (and only) formal introduction to
496 transportation engineering. As part of this initiative, the course was reimagined to explore how local examples can
497 help illustrate principles of equity and accessibility in daily life. The curriculum also prompted reflection on the
498 history of transportation systems and how evolving technologies have shaped the structure of modern cities. These
499 reflections informed the development of new course content, including revised activities, updated materials, and
500 the integration of equity and accessibility topics throughout. Some of the content developed in this context also
501 aligned with themes covered in CIVE410, a fourth-year elective focused on air pollution, which emphasizes urban
502 air quality, traffic-related emissions and waste pollution. The funding allowed for the hiring of another research
503 assistant to expand materials addressing environmental justice in the context of air and waste pollution.

504 **4. Developed curriculum**

505
506 Building our curricular ‘nest’ with this iterative looping process with instructors across the undergraduate program
507 built on already present strengths, especially in sustainability content (**Table 2**). Our overall initiative developed

508 content in four required 2nd and 3rd year classes in addition to content for 4th year electives. The content developed
509 in this initiative was biased towards water resource and environmental engineering, although it also included
510 transportation engineering and building science. Importantly, we integrated this content across the program, through
511 the program-level learning objectives and clarifying how and where content was introduced, developed and
512 mastered. Overall, 23 lecture slide decks and 8 in-class activities were developed through this initiative. Table 3
513 summarizes this content relative to the three departmental level learning objectives (LO):

514
515 LO 1: Identify how sustainability challenges and environmental racism interrelate and relate to civil
516 engineering

517 LO 2: Analyze, describe and incorporate sustainability science, equity, and environmental justice into the
518 design process

519 LO 3: Develop skills to improve personal and organizational practices for sustainability and EDI

520

521 The majority of the content was developed for learning objective 1, which was focused on ‘identifying’, a relatively
522 low level of understanding in Bloom’s taxonomy. A lesser amount of content developed for learning objective 2
523 can be considered higher on Bloom’s taxonomy in the applying or analyzing level. The least amount of content was
524 developed for learning objective 3, which focuses on personal and professional skills. Future work could better
525 balance the content between these learning objectives. These three learning objectives synthesize and relate to the
526 three equity-centred aspects (equity as a goal, knowledge system and competency) but are not directly derived from
527 them.

528

529 To give a better sense of the content and how it is integrated into different courses, we describe three specific
530 activities from three different courses: two required 3rd year courses (that were the focus of individual projects in
531 this initiative), and a 4th year elective to highlight how this content can be extended beyond core required courses.
532 For each of these examples we include why this is important; what was developed; how it fits into the course and
533 the overall initiative; how has it changed the course; and any reflections, learnings, student feedback, and anecdotes.

534 **Sustainable water resources (CIVE 340) taught by Tom Gleeson**

535 This course includes lectures on ‘Water resources and environmental justice’ and ‘water resource sustainability’
536 and a number of related class activities and assignments. One example from this course is an in-class activity
537 exploring the connections between flooding, climate change, and environmental justice.

538

539 *Why this is important:* Flooding is one of the most immediate and inequitable climate hazards affecting Canadian
540 communities. With climate change increasing the intensity and frequency of extreme precipitation events, the spatial
541 and social distribution of flood risk is also shifting. This makes it essential for future civil engineers to understand
542 not just the hydrological mechanics of flooding, but also how social vulnerability, colonial histories, and
543 infrastructure design influence who is most affected—and how we can design for justice. This activity directly
544 engages students in these intersections, grounding technical knowledge in real-world social and environmental
545 challenges.

546

547 *What was developed:* This in-class breakout activity engages students in mapping flood risk and social vulnerability
548 across a Canadian city using publicly available tools: WRI’s Aqueduct Floods and the Canadian Census Mapper. It
549 asks teams to evaluate present and future flood scenarios under different climate conditions, analyze the socio-
550 spatial dimensions of vulnerability, and brainstorm design interventions that could reduce disproportionate impacts.

551 Students are also prompted to critically consider how infrastructure decisions in British Columbia—like flood
552 protection and recovery—can integrate environmental justice and ecological values.

553

554 *How it fits into the course and overall initiative:* This activity is part of a module on open channel flow and flood
555 routing, but significantly expands the scope to connect hydrology with climate adaptation and justice. It directly
556 contributes to two of the course learning objectives: 1) identify the appropriate hydrologic, hydraulic, sustainability
557 and equity tools to address local to global water resource problems; and 2) apply hydrologic, hydraulic,
558 sustainability and equity tools and understanding to water resource problems including stormwater management,
559 drinking water supply, river routing and flooding. The activity also supports the broader program initiative to center
560 equity, sustainability, and social responsibility as core engineering competencies.

561

562 *How has it changed the course:* Integrating this activity has meaningfully shifted the course culture. Rather than
563 treating flooding solely as a hydraulics problem, students now discuss it as a socio-technical and ethical challenge.
564 It has opened space for students to express values around justice and sustainability within technical topics. The
565 conversation about who benefits and who is left behind in infrastructure decisions has become a more regular feature
566 of class discussions. The activity also paved the way for deeper engagement in final project work, where students
567 often choose to explore the equity dimensions of water systems.

568

569 *Reflections, student feedback, and anecdotes:* Student feedback highlighted how eye-opening it was to see census
570 data overlaid on flood risk maps—especially noticing how low-income, immigrant, or racialized neighborhoods
571 often intersect with higher risk areas. One student commented, "This was the first time I realized that being an
572 engineer means thinking about people, not just water." The blend of quantitative mapping and critical discussion
573 has proven to be a powerful learning experience, with several students noting this was one of the most memorable
574 activities of the term.

575

576 More recently, some students questioned how environmental justice content relates to water resource engineering
577 and suggested they wanted to focus only on math. This feedback helped reframe the content in the class,
578 emphasizing the importance of viewpoint diversity to bring more voices into the classroom; grounding first in
579 engineering problems and code of ethics; and shifting from an advocate who assumed everyone is interested in this
580 content to a facilitator who encourages students to come to their learning themselves.

581 **Transportation engineering (CIVE 360) taught by Laura Minet**

582 This course includes lectures on transportation accessibility and equity, environmental impacts of transportation
583 systems, and mitigation strategies, and related in-class activities and assignments.

584

585 *Why this is important:* Many people either cannot drive or choose not to, and instead depend on public transit and
586 active transportation modes such as walking and cycling. Yet, most of our cities have been built with a car-centric
587 design. As cities continue to evolve—especially in the face of climate change—it is critical that future transportation
588 engineers recognize the importance of creating systems that are not only sustainable, but also equitable and
589 accessible for all.

590

591 *What was developed:* We began by designing course activities that encouraged students to reflect on the role of
592 transportation systems in their communities and how these systems affect people's lives at different scales. At the
593 macroscale, this included walking tours of one of two Victoria neighbourhoods—Cook Street Village and Oak Bay

594 Village—prompting students to analyze how the built environment supports or hinders mobility and accessibility.
595 At the microscale, students developed videos on specific intersections or routes in Victoria, identified transportation
596 challenges, and proposed context-sensitive improvements.

597 A set of lecture slides was also developed to introduce core concepts of equity and accessibility, including the
598 distinction between horizontal equity (equality of treatment) and vertical equity (fairness based on differing needs
599 or disadvantages). These lectures were paired with in-class discussions of real-world Canadian policy examples,
600 such as free public transit initiatives, highway expansion projects aimed at congestion relief, and UVic’s parking
601 fee structure. The curriculum was further supported by lectures on the environmental impacts of transportation and
602 potential mitigation strategies, introducing students to the principles of environmental justice and the Avoid–Shift–
603 Improve framework as a strategy for reducing the sector’s environmental footprint.

604 *How it fits into the course and the overall initiative:* As the only transportation course for civil engineering students
605 at UVic, my goal is to provide the students with a broad understanding of the basic principles and methods used by
606 engineers and planners in the planning and design of transportation systems. In particular, they learn about the
607 fundamentals of transportation engineering, the safe systems approach to road safety, and the sustainability of
608 transportation systems. As such, the course includes design aspects of transportation (e.g., highway capacity,
609 geometric alignment, superelevation, travel demand), and more “societal” aspects, (e.g., energy demand,
610 environmental impacts.) One of the four core intended learning outcomes of the course is: “By the end of the course,
611 you will appropriately define sustainable transport, describe its various pillars, explain the main energy
612 requirements of transportation systems and identify the environmental and societal implications of transportation
613 systems.” Integrating concepts of equity and accessibility has been essential to provide a complete picture of the
614 various aspects of transportation systems.

615 The overarching objective presented above is supported by specific intended learning outcomes tied to individual
616 lectures. For the lecture on "Environmental Impacts of Transportation Systems," the intended learning outcome is:
617 “You will effectively summarize the impacts (environmental, health, welfare, societal, ecological) of
618 transportation.” For the lecture on "Transportation Accessibility and Equity," the intended learning outcome is:
619 “You will effectively contextualize common issues of transportation accessibility and equity in Canada.” These
620 targeted outcomes reinforce the course’s commitment to preparing students to think critically about sustainability,
621 environmental justice, and inclusive design in the field of transportation engineering.

622 *How has it changed the course:* While accessibility and equity are not directly mentioned in the group project that
623 redesigns local roads or intersections, their consideration has come up in the final designs proposed. This
624 emphasizes the importance of embedding concepts of equity, accessibility and sustainability within the course rather
625 than presenting them separately: the students ultimately consider them naturally and are more likely to design
626 inclusive systems in the future. Additionally, many students have expressed appreciation for the inclusion of these
627 topics, citing them as a distinctive strength of UVic's civil engineering program and a compelling reason for
628 choosing to pursue their studies here.

629
630 *Reflections, learnings, student feedback, anecdotes:* While I acknowledge that transportation accessibility and
631 equity vary across countries, the intended learning outcome is specifically focused on the Canadian context. This
632 focus aligns with the career trajectories of most UVic civil engineering students, who are likely to work in British
633 Columbia or elsewhere in Canada. However, this emphasis does not exclude global perspectives—students are

634 encouraged to draw on examples from transportation systems they have experienced or studied in other countries,
635 and to reflect on how these comparisons can inform their understanding of accessibility and equity at home.

636
637 **Drinking Water Contaminants (CIVE 448) taught by Heather Buckley and Luiz Henrique Da Silva Correa**

638
639 This course is centred around a final group design project in which students propose green interventions in the life
640 cycle of trace metals in drinking water to protect human health and the environment, drawing on green chemistry,
641 environmental justice, life-cycle assessment, toxicology, biomimicry, water treatment technologies, and green
642 technological interventions. The projects target metals intentionally used in human activities (e.g. chromium in the
643 passivation of structural steel, manganese in arc welding, lead in automotive batteries): systems that have been
644 designed and therefore can be redesigned. Modeled on the Greener Solutions program at the Berkeley Center for
645 Green Chemistry (Schwarzman and Buckley 2019), this fourth-year undergraduate civil engineering elective has
646 expanded to a cross-disciplinary offering where chemistry and civil engineering students work together on project
647 teams.

648
649 *Why this is important:* Trace metals in drinking water pose a significant threat to both human health and the
650 environment, with their impacts often disproportionately affecting marginalized communities due to the location of
651 production and disposal. Students learn to design “upstream”, generating equitable, and environmentally
652 responsible solutions to water contamination challenges to protect public health and the environment through the
653 entire lifecycle.

654
655 *What was developed:* Prereading, lecture slides, assignments, and in-class activities to integrate environmental
656 justice, equity, and environmental racism with specific real-world case studies and reflections on how these
657 principles align with engineering code of ethics and guidelines. A new in-class activity has project teams analyze
658 the life cycle of a disposable chopstick from a downtown Victoria restaurant through the lens of environmental
659 justice and equity. Students step away from the challenge of their final design projects, recognizing that they do
660 already possess knowledge and intuition to think about and design around environmental justice. Finally, students
661 were asked to incorporate environmental justice and equity considerations into their final design project. This
662 included identifying which communities might be impacted by their proposed interventions, how those impacts
663 might differ across social and spatial lines, and what modifications could enhance the equity and sustainability of
664 their designs.

665
666 *How it fits into the course and the overall initiative:* Originally taught in the second half of the course, this content
667 was recently moved to the second lecture. The lecture and activity reinforce two key departmental learning
668 objectives (LO 1 and LO 2). They help students understand how environmental justice and racism intersect with
669 sustainability and water contamination challenges (LO 1), a topic which is tied particularly strongly to the existing
670 “toxicology and hazard” module in the course. The students are further encouraged to integrate these dimensions
671 into their engineering design process (LO 2), particularly through the explicit link to life cycle analysis, reinforcing
672 concepts first introduced in 2nd year core courses.

673
674 *How has it changed the course:* The material has fundamentally shifted how the students evaluate their final design
675 recommendations. Moving the material to the beginning has further reframed the course around equity,
676 sustainability, and environmental justice as foundational starting points for engineering practice and design.
677 Considerations of environmental justice, equity, and sustainability began to appear not only during lecture

678 discussions but also consistently throughout students' assignments (including those where EJ was not on the rubric)
679 and final design projects. For the final project, students were asked to propose three green interventions to address
680 a water contamination challenge. Following the course adjustments, most, if not all, of the proposed interventions
681 included analysis and integration of environmental justice, equity, and sustainability into their design.

682
683 *Reflections, learnings, student feedback, anecdotes:* Overall, students were receptive and quickly learned how to
684 incorporate equity, sustainability, and environmental justice into their design work and assignments. We have
685 received occasional pushback from students about "bringing our politics into the classroom"; however, this has also
686 created space for important challenging conversations both with individual students who were struggling with the
687 material but knew they wanted to do better, and as full-class discussions modeling "calling in" of individuals
688 expressing "othering" worldviews of marginalized groups. As a white woman, Heather has had to tackle her own
689 discomfort challenging students when they express racist views.

690

691 **5. Reflecting on our initiative**

692 This initiative offered us many lessons and learnings. Here we focus on hard-earned, context-specific learnings
693 organized around a series of open-ended reflexive questions that could be useful for other similar initiatives in
694 different contexts. None of these questions have single, generalizable answers and can only be answered in specific
695 contexts. We discuss some of these questions below from our experience and leave others unanswered for future
696 consideration, reflection and discussion.

697

698 We grounded our initiative with the metaphor of a flying bird and nest. We experimented with different metaphors
699 such as a bridge with two abutments, a door with two locks, or the human-embodied metaphor of a person's spine,
700 head and heart. These metaphors or others might be more useful in other contexts. We found the bird with two
701 wings effective in our classes in a number of ways, including it bringing in a more-than-human ecological metaphor
702 into the classroom, in addition to its ability to be extended as a metaphor such as visualizing civil engineering
703 education as a heron rookery (Figure 2b, bottom right).

704

705 **5.1 Why and who builds the nest? Motivating curriculum development, assembling a resourced team and** 706 **navigating resistances**

707 **What are the motivations for equity-centred curriculum development, and do these motivations come from**
708 **top-down (university or departmental priority) or bottom-up (from individual faculty or students) sources?**

709 The motivations for our initiative are described in Section 1 (Why equity is important for civil engineering
710 education) and further motivated by the institutional alignment described in Section 2.2 which is an important
711 enabling condition of our initiative. All three of the projects in our initiative began as bottom-up efforts led and
712 championed by a single faculty member with other faculty members supporting and advising. This approach lent a
713 widespread but informal legitimacy to the initiative which we hope is enduring because it was elective. Individual
714 champions of a bottom-up approach would likely be more important in contexts where there is less institutional
715 alignment and support for such initiatives. Yet, bottom-up approaches are idiosyncratic and depend on specific
716 relationships, sustained bandwidth, and are not easily replicated. A different approach could be to mandate or
717 strategically incentivize this type of initiative with a top-down directive from university or departmental leadership.
718 For example, our departmental or faculty-level curriculum committees could have initiated, led and implemented
719 such changes. This approach gives more institutional legitimacy which can be important yet might alter the form
720 and quality of developed curriculum when generated due to obligation rather than support and interest. We speculate

721 that the presence of both bottom-up and top-down motivations for curriculum development would likely lead to the
722 most enduring and broadest impact.

723

724 **Who and what resources are building the nest?** Building a nest needs both people and resources. The nest
725 should probably be collaboratively built to spread out the burden, and because different people with different
726 identities and experiences will bring distinct building materials for a more robust nest. Section 2.3 argues that our
727 varied social locations and educational training are relevant and important in shaping our project and curricular
728 nest.

729 Enabling conditions of our initiative include champions to lead the projects, supervise research assistants, and
730 secure funding, and multiple, keen colleagues and support from the department chair and curriculum committee.
731 A limitation is that most colleagues in our department (like many other civil engineering departments) have
732 limited or no formal graduate or undergraduate training in environmental justice, EDI and sustainability science
733 but many have attended numerous workshops and training as an ‘add on’ or professional development. A possible
734 bias is that the initiative was led overall by white, cis-male settlers with engineering and quantitative training even
735 while the broader team and advisers was much more diverse in educational training as well as representing
736 multiple identities of race, gender, etc. Additionally, we did not explicitly include undergraduate students in our
737 curriculum development team (but sought student feedback formally and informally through courses) which other
738 initiatives may approach differently. Important unresolved reflection questions include: how did the identities and
739 experiences of the leadership and people involved in this initiative impact the outcome? For example, how would
740 this project have been different if led by people with more lived experience of oppression and how could this be
741 done while reducing the additional burden? Or what is the best role for people from dominant identities in this
742 work?

743

744 Time and money resources can also be important to ensure this work is not an extra burden and to validate efforts.
745 Important enabling conditions of our initiative were funding from the university to enable real time and resources
746 for research assistants in each project to do the heavy lifting. Another important unresolved reflection question is
747 how to best initiate and conduct this work if such time and money resources are scarce or not present?

748

749 **How to navigate resistance from colleagues and students in required and mandatory courses?**

750 A frequent discussion throughout our initiative was on whether equity-centred course content should be required
751 or elective material for students. In a practical sense, we focused on integrating equity-centred course content into
752 required courses in the engineering program, or only into elective upper-year courses. We decided it was
753 important to mainstream this content by working it into several required courses, and complementing these
754 introductory modules with deeper treatment of these concepts in elective courses. But it is also well known that
755 requiring anti-racism or EDI training can lead to backlash or entrenching racism (Bezrukova et al. 2016),
756 especially in the present political climate. So including any of the equity-centred content in any required course
757 needs to be done thoughtfully and strategically in terms of both the content (is this essential to engineering?) and
758 the delivery (how can this be taught to bring students along?). Some strategies we have found useful are centring
759 and embedding this work rather than making it as an add-on as well as shifting from an advocate, who assumed
760 everyone is interested in this content, to a facilitator, who encourages students to come to their learning
761 themselves ('show' instead of 'tell'). Depending on the context and timing, readiness and interest in engaging with
762 equity-centred curriculum development may differ from our experience and can be highly variable. We observed
763 a critical mass of enthusiasm but if we had more pushback, it could slow or halt momentum. In other contexts,
764 and over time, additional or alternative strategies may be needed to support this work.

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5.2 How to balance the nest and the wings: prioritizing program or courses-level development and balancing equity with technical curriculum

Is it better to prioritize overall program development or individual course(s)? Our initiative brought together projects at both the course and program level which can be useful for reflecting on the value of different scales of curriculum development. Having equity-centred content only in specific, individual courses felt siloed, so we argue that focusing on the program rather than a single course or small number of courses is more impactful. Students learn content in an iterative way, gradually progressing beyond rote memorization to higher-order thinking skills (as described by example by Bloom’s Taxonomy), so we argue that a number of courses doing a little is more impactful than a single or small number of courses doing a lot.

Our specific context and initiative again had enabling conditions including being a relatively young department with less inertia and resistance to change and where seeds of change were already in place (program priorities, specific courses, co-op program). An important limitation for our civil engineering program is that we have limited influence over the shared 1st year program.

How to balance the equity-centred and technically-centred wings? We have argued for embedding equity-centred content rather than this wing being in opposition or competition with the technically-centred wing. Not every course needs content from each wing: some courses and instructors will prioritise the importance of one wing or the other. When equity-centred content is included in a course, we have found it important for there to be a certain minimum depth and intention to include this content. Otherwise it can risk being or appearing like greenwashing, virtue signalling or performative, especially to equity-deserving students.

But since there is a finite amount of teaching time and resources, the two wings need to be prioritized on a course-by-course basis, and balanced across courses and programs. Several colleagues have shown interest in integrating this type of content into their teaching but have expressed concerns about limited time and the challenge of deciding what existing material to remove. We have found that developing the equity-centred content requires significant time and resources, but need not take a significant amount of in-class time. Bringing this framing to the overall course framing and/or a few strategic slides or classroom activities can be valuable and impactful on individual courses. Even in the courses with the most equity-centred content, this is usually less than 10% of the class time - balancing the wings need not imply an even distribution of time or resources.

Even in an environment with strong alignment of institutional priorities across multiple levels, variation in how faculty prioritize teaching time and resources is expected. Some colleagues view this content as less central to engineering, or as secondary to mastering fundamental concepts. In discussions with these colleagues, we focus on the arguments from Section 1 highlighting the importance of engineering ethics and specific examples of equity-related engineering failures in their domain, and how technical analysis can be strengthened and made more robust when complemented with an equity-centred approach. We find it useful to frame the challenge as one where programming does not require sacrificing one wing to develop the other, but instead seeks approaches that strengthen both in alignment.

Our initiative encountered specific limitations in balancing the two wings. The least amount of content was developed for learning objective 3, which focuses on personal and professional skills but these skills are further

809 developed in the co-op program (Section 2.2). The content developed in this initiative was biased towards water
810 resource and environmental engineering, although it also included transportation engineering and building
811 science. As described in Section 1, we do not explicitly differentiate between Truth & Reconciliation and EDI
812 work although when teaching in the context of the Canadian settler state this can be important. More generally, it
813 is useful to reflect on the histories of different marginalized groups and reduce flattening their different
814 experiences. We see this as a limitation of our initiative that we were learning about during the initiative so were
815 not able to fulsomely consider during the project. We are currently part of a more recent initiative aiming to
816 Indigenize civil engineering curriculum across Canada.

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825 Couture and Julia Tay.

826 **Supplemental Material**

827 We have included supplemental material that can be found at this [URL](#) (upon acceptance the Supplemental
828 information will be deposited in Dataverse, UVic's permanent institutional repository. The supplemental material
829 includes text on the strengths and limitations of our equity-centred framing as well as the relation of this initiative
830 to engineering accreditation.

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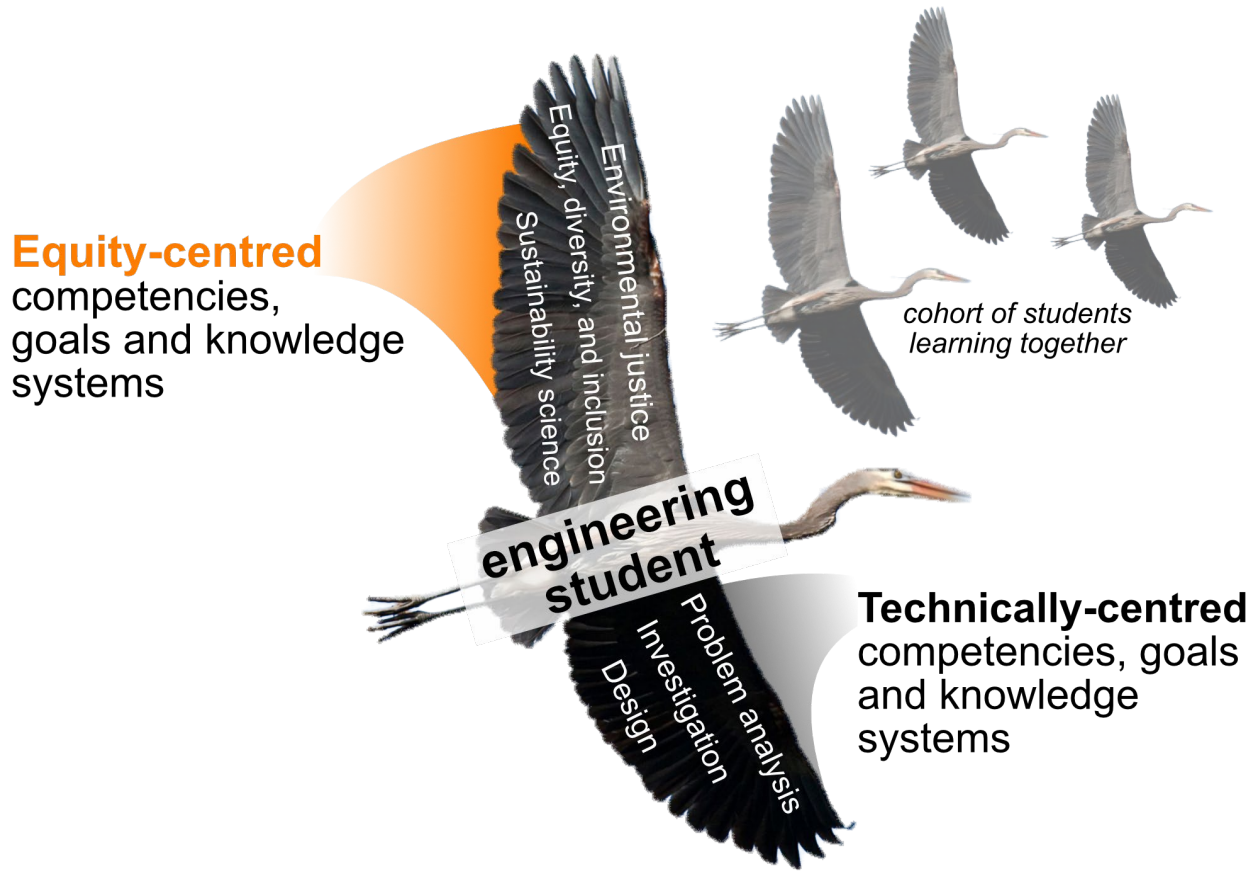
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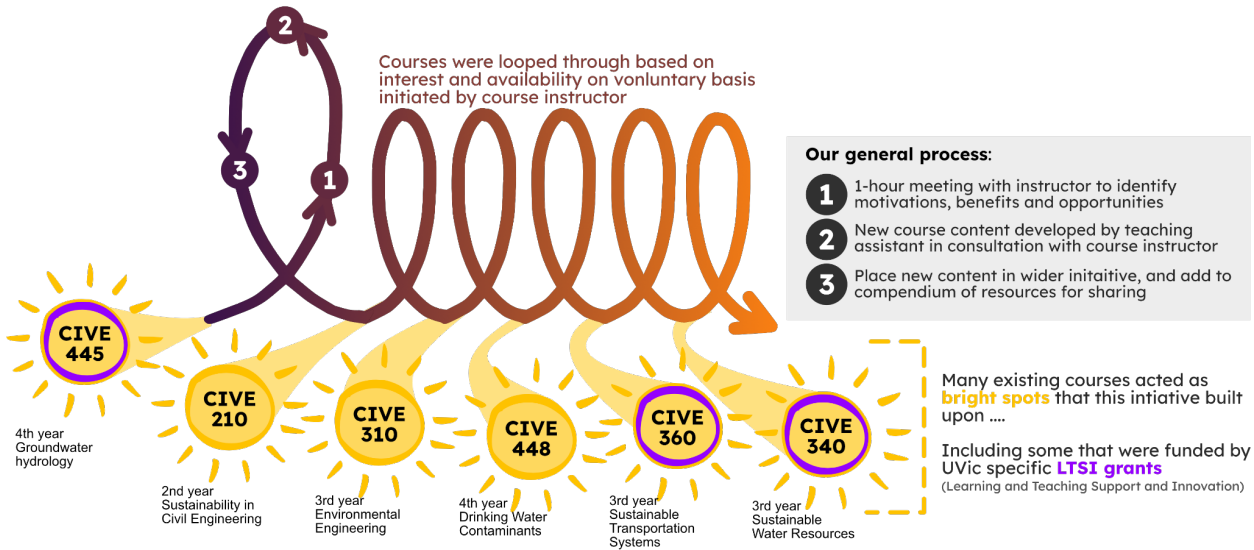
FIGURES AND TABLES



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Figure 1. Equity-centred and technically centred competencies, goals and knowledge systems represented as two wings of an engineering student represented as a soaring bird. Equity centred approaches include environmental justice, EDI and sustainability, each of which have foundations, strengths and limitations that are distinct

a Bottom-up, emergent process of curriculum development



b Student experience with the developed curriculum

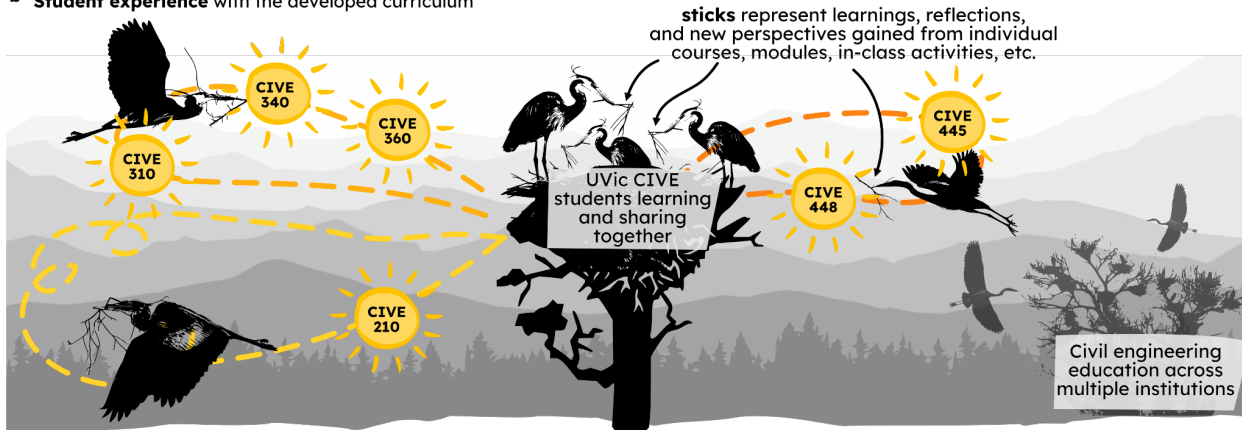


Figure 2. Looping processes across course development (instructor side) and learning experience (student side) of this curriculum initiative. (a) The iterative looping process of engaging with different instructors on different courses including the involvement of previous ‘bright spot’ courses. The overall initiative and most of the developed content is shared openly on the initiative website (<https://oac.uvic.ca/civelearningandteaching/>). (b) Visualising the UVic civil engineering (CIVE) curriculum as a heron’s nest and the looped, iterative learning of students to enable learning of the equity-centred content. The overall initiative can also be explored from a student’s perspective on the initiative website.

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Table 1: Goals, knowledge systems, and competencies of equity-centred and technically- centred aspects of civil engineering. This table does not explicitly consider inclusion and diversity, but these EDI aspects could be the important future work.

	Equity-centred	Technically-centred
Goals	Design processes that produce sustainable, just outcomes for all, especially marginalized communities	Develop efficient, optimized, and safe designs that meet client, often without equitable outcomes as a goal
Knowledge systems	Multiple and plural: technical, qualitative, Indigenous, cultural, experiential, artistic	Primarily technical and quantitative, including peer-reviewed scientific literature and industrial standards
Competencies	<p>Ability to recognize, name and address unsustainable, structural inequalities</p> <p>Ability to engage meaningfully with the community</p> <p>Ability to reflect on one’s biases and positionality awareness</p>	<p>Math, science, and engineering principles to solve technical problems</p> <p>Interpersonal and teamwork skills that are decontextualized from power and justice issues</p>

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Table 2. How the program-wide, equity-centred learning objectives are delivered in the undergrad program. This table highlights the second and third year in our program where most of the required civil engineering content is delivered. Blue cells highlight content developed in this initiative; yellow cells highlight bright spots in our curriculum with previously developed (existing) content; grey cells indicate content we plan to develop in the future. How different courses to each other can be further explored on the initiative website (<https://oac.uvic.ca/civelearningandteaching/>). Mandatory courses are denoted by a ■ and elective course by a □ symbol.

Learning objectives	Second year (first term)	Second year (second term)	Third year (first term)	Third year (second term)	Fourth year (both terms combined)
Identify how sustainability challenges and environmental racism interrelate and relate to civil engineering	■ Geomatics engineering (CIVE 299) Spatial patterns of disproportionate impacts in transportation, water, buildings etc	■ Sustainability in civil engineering (CIVE 210) Global change; sustainability theory/history, systems thinking, various analytical methods	■ Introduction to environmental engineering (CIVE 310) Case examples of sustainability challenges and environmental racism	■ Sustainable water resources (CIVE 340) Case examples in hydrology/water resources engineering	<input type="checkbox"/> Groundwater hydrology (CIVE 445) Applying sustainability frameworks to groundwater with equity perspectives.
		■ Building Science Fundamentals (CIVE 295) Up-front motivation around sustainability, Indigenous housing module/lesson/ project	■ Environmental policy (CIVE 315) Environmental problem identification across scales; Indigenous and settler government policy	■ Sustainable transportation systems (CIVE 360) Access inequalities, linking sustainable transport with fundamentals	<input type="checkbox"/> Resilient smart cities (CIVE 411) Urban systems design integrating equity, resilience, and infrastructure access.
Analyze, describe and incorporate sustainability science, equity, and environmental justice into the design process	■ Construction and project management (CIVE 270) sustainability management in construction industry; LEED and other certification; implicit bias and equity	■ Sustainability in civil engineering (CIVE 210) Sustainability and equity as design objectives, integrating these into design process	■ Introduction to environmental engineering (CIVE 310) Tools to better define problems by 'sustainability' and/or 'EJ' dimensions/considerations	■ Sustainable water resources (CIVE 340) EJ and water sustainability tools for water resources problems	■ Cross-disciplinary capstone design (CIVE 400) Capstone designs applying sustainability and equity in real projects
		■ Building Science Fundamentals (CIVE 295) Indigenous housing module/lesson/		■ Sustainable transportation systems (CIVE 360) Strategies for increasing	<input type="checkbox"/> Drinking Water Contaminants (CIVE 448) Designing interventions to protect health, reduce inequitable exposure risks

		project	<p>■ Geotechnical engineering (CIVE 385) Integrating sustainability in geotechnical design criteria (soil strength)</p>	<p>sustainable transport systems through engineering design and linkage to other initiatives</p>	<p>□ Water and sanitation for low resource contexts (CIVE 444) Addressing global inequities through public health engineering solutions</p>
		<p>■ Civil engineering materials (CIVE 285) Life cycle assessment, economic and equity lens in project using EDI guidelines of Canadian Engineering Qualifications Board</p>		<p>■ Design of steel and timber structures (CIVE 351) Sustainability, EJ dimensions of LCA of structures (which could include material from CIVE 448)</p>	<p>□ Infrastructure engineering for Indigenous communities (CIVE 444) Co-developing infrastructure with Indigenous communities and knowledge system</p>
<p>Develop skills to improve personal and organizational practices for sustainability and EDI</p>	<p>■ Construction and project management (CIVE 270) EDI as core to professional project practices</p>		<p>■ Environmental policy (CIVE 315) Representation, positionality & role in policy outcomes</p>		

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1028 **Table 3. Presentations, activities and assignments developed during the initiative. Most of the developed**
 1029 **content is shared openly on the initiative website (<https://oac.uvic.ca/civelearningandteaching/>).**

Learning objective	Presentations	Activities and assignments
Identify how sustainability challenges and environmental racism interrelate and relate to civil engineering	<ul style="list-style-type: none"> ● Why environmental justice in engineering? ● Why sustainability in engineering? ● What is environmental justice? (with additional slides) ● What is environmental racism? ● What is environmental inequality? ● What is sustainability? ● Sustainability threshold concepts ● Environmental justice tools for engineers? (with additional slides) ● Planetary boundaries step by step ● Analysis methods for environmental justice ● IPAT framework ● Cities focus on Sustainable Development Goals ● Environmental justice with water resource focus ● Transportation equity ● Sustainability with water resource focus ● Frameworks for sustainability in water resources 	<ul style="list-style-type: none"> ● Activity: Water resources and environmental racism in BC ● Activity: Core elements of water sustainability plan ● Activity: Groundwater Sustainability in social-ecological and earth systems ● Activity: Intersection flooding climate change environmental justice ● Assignment: Groundwater related environmental racism and injustice ● Assignment: Groundwater report for Indigenous Community ● Assignment: Walking tour of a neighbourhood in Victoria ● Assignment: Video project on urban road design issue ● Activity: Transportation inequities
Analyze, describe and incorporate sustainability science, equity, and environmental justice into the design process	<ul style="list-style-type: none"> ● Engineering for sustainability in a complex world ● Design patterns ● Environmental impact assessment ● Engineering approaches for groundwater sustainability 	<ul style="list-style-type: none"> ● Activity: Environmental justice of chopstick life cycle ● Assignment: air quality- and solid waste-related environmental justice
Develop skills to improve personal and organizational practices for sustainability and EDI	<ul style="list-style-type: none"> ● Identifying social location, and equity, diversity, and inclusion overview 	<ul style="list-style-type: none"> ● Activity: Social location and dominant culture

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