

WIP: Shifting to a Strengths-Based Mindset to Center Indigenuity in Engineering Education with a Threshold Learning Framework

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Craig is a structural engineer with a deep interest in understanding how structures behave and a passion for sharing that knowledge with the next generation of emerging engineers. As a Worimi man, Craig has a desire to inspire other Indigenous people to consider a career in engineering.

Craig has worked in a diverse range of roles in the construction industry including 7yrs in manufacturing as a truss and frame designer, 2yrs on a construction project as a site engineer, 3yrs as a consulting structural engineer working predominantly on high-rise buildings, and more than a decade in academia.

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Abstract

This work-in-progress paper builds on preliminary findings from our research project to develop a threshold learning inventory and framework for centering First Nations Australian value systems, perspectives, and Knowledges in engineering education [1], [2], [3]. Our findings stem from semi-structured interviews (n = 32) with First Nations Australian Elders and Knowledge holders, and engineering educators, students, and practitioners. Based on our in-progress thematic analysis [4], [5], we describe a threshold of *shifting to a strengths-based mindset and challenging stereotypes*. We also highlight First Nations Australian participants' discussion of *indigenuity* (Indigenous ingenuity) [6, p. 35] in engineering. We hope that a better understanding of these thresholds will contribute to a framework for transforming engineering education to center First Nations Australian engineering approaches.

Keywords: *First Nations Australian engineering, Indigenous engineering, threshold concepts*

Research Team Positionality

Our research team brings together a Ngemba computer science practitioner, researcher, and educator, a Worimi engineering researcher and educator, a Chinese American PhD candidate in engineering education, and two non-Indigenous Australian engineering educators. We are committed to transforming engineering education so graduates will appropriately account for First Nations Australian engineering value systems, perspectives, and Knowledges in engineering practice. As part of respecting ethical protocol in this space, our research process prioritizes First Nations leadership. We collaborate with a Yugambeh, Quandamooka, Kabi Kabi, Yuggera, Kombumerri, Goreng Goreng, Ballardong, Whadjuk, and Yiman Elders advisory council to ensure cultural validation and integrity throughout the research process.

A Note on Terminology and Participant Identifiability

Throughout this paper, we respectfully use terms that we acknowledge are contested and limited. We write *First Nations Australian* to refer to Aboriginal and Torres Strait Islander peoples in the land that is now called Australia. We write *Indigenous* in adjective form to refer to First Nations outside Australia. We acknowledge that Indigenous peoples do not belong to one homogenous group. We also refer to *Country*. As Dr Danièle Hromek—a Saltwater woman of Budawang/Dhurga/Yuin and Burrier/Dharawal ancestry—describes, *Country* relates to the nation or cultural group and land that First Nations Australian peoples “belong to, yearn for, find healing from and will return to. However, Country means much more than land, it is their/our place of origin in cultural, spiritual and literal terms. It includes not only land but also skies and waters” [7, p. 2].

We also acknowledge Opaskwayak Cree scholar Shawn Wilson's work describing how it may be most respectful and appropriate to identify participants by name in order to honor an ethic of relational accountability [8]. As outlined in our ethics protocol and consent forms (University of Melbourne Ethics Approval Reference #: 2025-29824-73181-5), we identify participants by name where they have given consent and indicated this preference.

Introduction

Appropriately accounting for First Nations value systems, perspectives, and Knowledges strengthens engineering solutions and is essential to ethical engineering practice. Professional and academic engineering bodies in Australia—including Engineers Australia, the Australian Council of Engineering Deans, and Universities Australia—have acknowledged the importance of embedding First Nations Australian values [9] and perspectives in engineering education [10] and professional practice [11]. Engineering educators in universities across Australia are working to embed First Nations Australian engineering alongside engineering education [12], [13]. Many educators grapple with how to appropriately approach this curriculum transformation [14]. Capacity building for engineering educators in this space continues to be an important theme in the literature [15]. Our overarching research project seeks to develop a threshold learning inventory and framework to provide guidance on ways of meaningfully centering First Nations Australian value systems, perspectives, and Knowledges in engineering education. Through our framework, we hope to:

- 1) Describe an appropriate process for connecting with partners in First Nations Australian engineering to ensure positive outcomes in the communities of interest.
- 2) Identify threshold learning elements (concepts, capabilities [16], and values) in First Nations Australian engineering.

Research Approach

We continuously strive to prioritize First Nations Australian leadership throughout our research approach [1]. Our research approach is guided by seminal works and emerging publications describing Indigenous research methodologies [8], [17], [18], [19], as well as the Australian Institute of Aboriginal and Torres Strait Islander Studies Code of Ethics [20]. We collaborate with an Elders advisory council with Elders from Yugambah, Quandamooka, Kabi Kabi, Yuggera, Kombumerri, Goreng Goreng, Ballardong, Whadjuk, and Yiman lands. This ongoing collaboration is grounded in two research contracts: an Indigenous Cultural and Intellectual Property (ICIP) agreement and a collaboration agreement.

ICIP may include literacy, performing & artistic works, languages, Indigenous Knowledges, Indigenous resources, documents of heritage, and cultural property [21, p. XLVI]. Our ICIP agreement outlines terms around consultation, data and copyright material, research outputs, benefits, and how Elders/Knowledge holders will be credited. Our collaboration agreement outlines terms of respectful engagement, costs and payment methods, ICIP, and fees for service. These agreements were developed in partnership with the Elders advisory council. This ongoing collaboration between the Elders advisory council and research team works to ensure our research process is ethical, culturally valid, and demonstrates cultural integrity.

Threshold Learning Framework

Our research framework draws upon threshold concept theory [22] and the threshold capability integrated framework [16]. Threshold concept theory posits that there are essential elements of learning in a given discipline that are *transformative*, meaning that, once understood, these concepts are necessary for progressing in the discipline and open up areas

of understanding previously inaccessible to learners [22]. Meyer and Land also proposed that these thresholds may be *troublesome* (challenging for students to cross) and *reconstitutive* (requiring students to deconstruct and reconstruct prior understanding of a concept) [22], [23]. The threshold capability integrated theoretical framework brings together threshold concept theory with capability theory to define threshold knowledge capabilities as the abilities that learners need for practice in real professional settings [24].

In this paper, we focus on threshold learning elements (concepts, capabilities, and values) that are most *transformative*, *troublesome*, and *reconstitutive*. We seek to describe the threshold learning elements that engineers need for professional practice to appropriately center First Nations Australian value systems, perspectives, and Knowledges.

Connection to Existing Literature

Prior to our research project commencing in 2024, threshold learning elements in First Nations Australian engineering had not yet been described in the literature. In 2019, Gomeroi/Kamilaroi scholar Nikki Moodie proposed five threshold concepts in Indigenous Studies more broadly [25]. Wyllie-Runner et al. [26] later outlined how the threshold concepts framework is appropriate when considering decolonization in engineering education, but specific threshold concepts, capabilities, and values have not been defined.

Our overall project seeks to develop a threshold learning element inventory and framework to center First Nations Australian engineering in engineering education. We previously presented possible threshold learning elements derived from interviews with engineering students who had completed units that embedded First Nations Australian engineering in various capacities [2]. We described possible thresholds related to *understanding cultural and historical context as part of engineering design, place-based design, regenerative design, and understanding the “why” and “how” behind consultation with First Nations Australian peoples and engineering* [2, p. 5]. Here, we build on our previous work by considering contributions from additional participant groups described in the Methods section.

Methods

Preliminary findings in this paper stem from our in-progress thematic analysis [4], [5] of semi-structured interviews informed by a yarning approach [19]. Interview participants (n = 32) include First Nations Australian Elders, Knowledge holders, engineers, and engineering educators, non-Indigenous engineering educators and practitioners, and students who have completed units that embedded First Nations Australian perspectives. Our preliminary findings suggest that engineering practitioners, educators, and students must cross thresholds to meaningfully connect with First Nations Australian value systems, perspectives, and Knowledges. We have previously described how educators often must cross a threshold to recognize the relevance of First Nations Australian engineering in engineering education [3]. Here we describe an additional threshold for engineers, educators, and students: *shifting to a strengths-based mindset and challenging stereotypes*. We then discuss *indigenuity* (Indigenous ingenuity) [6, p. 35] as an essential strength to highlight when facilitating this shift.

Preliminary Findings

Shifting to a Strengths-Based Mindset and Challenging Stereotypes

Across our interviews with Knowledge holders, educators, and engineers, multiple participants highlighted the importance of challenging stereotypes and shifting from commonly held deficit narratives about First Nations Australian peoples to a strengths-based mindset. As one educator noted:

“I think students often come in . . . and it's not only students, and it's not only with regard to Indigenous culture . . . but I think come in with like, a deficit mindset, and a stereotype of what an Indigenous person is, where they're . . . living remotely . . . someone who's living remotely in, in the Northern Territory, for example, rather than, you know, living in an urban environment or all different environments around Australia. I think there's like a . . . monoculture, default mindset, um. . . that it's all, all the same, and, and, yeah, a deficit one, I think, is, is really, all too often a kind of a default mindset” (Educator Participant 4).

Here we see the educator describing initial stereotypes and a default mindset that students—and “not only students” but educators and engineers—must reconstitute in their understanding of First Nations Australian peoples. He specifies examples of some stereotypes that must be challenged, including the idea that all First Nations Australian peoples live in remote areas of Australia, and that Indigenous culture is a monoculture. This educator proceeded to outline how a deficit mindset can influence the engineering design approach:

“Unfortunately, [it's] like verging on, like a white savior type thing of like: ‘I'm a second-year engineering student, so I can solve this community’ . . . and a focus on deficits I think is quite common . . . I think the deficit one is . . . quite ingrained. And can be kind of like jarringly apparent sometimes. And . . . I think . . . there's a risk that we reinforce it through, you know, posing design briefs for students (Educator Participant 4).

This educator's description of the deficit view as “quite common” and “quite ingrained,” suggests that many students may find it *troublesome* to shift, given that a strengths-based mindset contradicts their previously held beliefs about First Nations Australian peoples. He also suggests that the way that design briefs are posed to students may inadvertently reinforce the deficit mindset of solving problems *for* a community, rather than working *with* a community to co-design an appropriate solution that is fit-for-purpose to achieve a co-identified outcome. Similarly, another educator stated:

“Probably the biggest thing I saw (it was harder to pick up in international students), but [with] domestic students, you'd often have conversations with them . . . towards the end of semester, and they'd say things like, ‘you know, I've only ever seen Aboriginal people as, you know, the gap or socioeconomic indicators. And, you know, these are people we need to help.’ They hadn't seen it as presented as a positive and alternate worldview, or, you know, a set of aspirational goals. You know, we're trying to present things in a very constructive, um, future-looking way. And that's not the

way people had engaged with Aboriginal Australia. It was all about the past, and what that's caused for people living in the present, but not as a continuity of values and community, and things like that. So, for them, it was quite a different conception of what Aboriginal Australia is” (Educator Participant 10).

This description points to a transformation in student thinking. Educator Participant 10 described how students often expressed starting from a place of seeing “Aboriginal people as, you know, the gap” and as “people we need to help.” Over the course of the semester, the students went through a transformation toward recognizing a “positive and alternate worldview” as the educators work “to present things in a very constructive” way (Educator Participant 10). Given this, it is important to consider some of the strengths that educators may focus on when facilitating this transformation. One of the strengths that First Nations Australian interview participants articulated was *indigenuity in engineering*.

Indigenuity in Engineering

Commenting on the importance of challenging deficit mindsets and highlighting indigenuity in engineering, one Knowledge holder described how First Nations peoples are generally

“viewed as being sort of down on the bottom of the . . . ladder in terms of . . . input into Australia, and the future of Australia . . . And over time, the more I spent being out with community people in very remote areas, interacting, engaging, understanding where they're coming from, understanding the context that they're in: You get to gauge how the strong level of sophistication that actually is occurring within Aboriginal communities . . . often gets overlooked” (Knowledge Holder Participant 1).

Here we see Knowledge Holder Participant 1 describing the common stereotype and deficit view of Aboriginal communities “as being sort of down on the bottom.” He then describes that time spent “out with community people in very remote areas” is transformative for seeing how indigenuity “often gets overlooked.” From “interacting, engaging, understanding where they're coming from, understanding the context that they're in,” he developed an awareness of “how the strong level of sophistication that is actually is occurring within Aboriginal communities . . . often gets overlooked” (Knowledge Holder Participant 1).

As an example of indigenuity in engineering that stems from long-term, context-based observance of nature, Knowledge Holder Participant 1 described “*the plying of wax, spinifex wax, heating it up, cooling it down, working it, all those things, and they just set like concrete.*” He then suggested showing examples of indigenuity in engineering to demonstrate “*how important that actually is, and trial [them] against newer engineering options and see which one works longer, or has better impact or better outcomes.*” Showing such examples of indigenuity in engineering is one way to help people move away from deficit mindsets toward appreciating the sophistication in First Nations Australian engineering that “often just gets overlooked” (Knowledge Holder Participant 1).

Further explaining this indigenuity in engineering, this Knowledge holder reflected on how

“we’ve seen continuously how, when you’re going back to either tools or . . . implementation of understanding the environment and the context that people are in, you get a really sort of deeper understanding of how sophisticated [First Nations Australian engineering] is” and “all those things are interconnected and linked along with the environment and the Country, and the songs that go with it, and the things that people know and understand in their . . . cultural activities” (Knowledge Holder Participant 1).

In this reflection, Knowledge Holder Participant 1 emphasizes that the deep understanding of environment and context are interconnected with Country, songs, and cultural activities, all of which contribute to indigenuity in engineering. However, he experiences that

“generally, non-Aboriginal people in Australia really struggle to understand any of those sorts of concepts [e.g. Country and interconnectedness], and it’s too hard for them to even think about. And generally, they don’t want to [pause] think or believe that that’s important before they go into those communities or those projects. But if we could find a way to actually show examples of how important that actually is, I think you might go some way to making people more aware of it” (Knowledge Holder Participant 1).

The way Knowledge Holder Participant 1 describes non-Aboriginal peoples’ “struggle to understand any of those sorts of concepts” suggests that the depth of indigenuity in engineering may be a *troublesome* concept for many engineers.

Our interviews with First Nations Australian engineers provided additional insight into elements of indigenuity such as *Country, designing with Country rather than on Country, and relationality and interconnectedness*. Wajarri man and practicing engineer Josh Loyd reflected that

“the [threshold] I spend the most time explaining to people that I interact with [is] this concept of Country. What it means . . . and specifically in respect to designing. . . engineering with Country versus on Country . . . the concept that Country is not just a physical place. That it . . . has, not necessarily personhood, but spiritual[ity]. And then the relationships that then come from that: the treating Country like a person or like kin . . . changes the way that you view. Because ultimately, when you’re designing on Country, it can be quite, uh, connotative of, you know, negative things (not necessarily considering you’re doing it for, [being] extractive) . . . Whereas starting with Country, you know, it then becomes more about that relationality” (Wajarri man and practicing engineer Josh Loyd).

Loyd’s description of Country as more than “just a physical place” aligns with Moodie’s discussion of Country as a threshold concept in Indigenous Studies, which requires an understanding that “Indigenous people’s ontological relationship to Country . . . cannot be reduced to either land or place” [25, p. 740].

While a full discussion of these elements sits outside the scope of this paper, we suggest that these elements are often new ideas for engineering educators, students, and practitioners.

These ideas may also contradict previous understandings of what constitutes engineering and which forms of knowledge are privileged. These factors may explain why the depth of indigenuity in engineering may be *troublesome* to understand and appreciate. Despite this challenge, practicing engineers must *reconstitute* their understanding and acknowledge indigenuity in engineering to recognize the relevance and appreciate why they must appropriately consider Indigenous engineering alongside dominant engineering approaches.

Preliminary Recommendations & Future Work

This work-in-progress paper builds on our previous work to develop a threshold learning framework for centering First Nations Australian engineering in engineering education. Our future research will continue describing threshold learning elements and working toward a threshold learning framework. Our next step is to hold an integrating focus group phase [27] where we gather potential thresholds and facilitate focus groups with research participants from all past participant groups to develop a threshold learning element inventory.

We hope that this paper demonstrates the importance of shifting to a strengths-based mindset with respect to First Nations Australian peoples, value systems, perspectives, and Knowledges. We discussed the strength of indigenuity in engineering. We briefly introduced elements that contribute to indigenuity in engineering, including *Country*, *designing with Country rather than on Country*, and *relationality and interconnectedness*. We recommend that engineering educators co-design with First Nations peoples how to acknowledge and highlight indigenuity throughout engineering curricula as they begin or continue the journey of centering Indigenous value systems, perspectives, and Knowledges. We also recommend that educators understand and discuss with students how interconnectedness and observance of nature are integral to indigenuity in engineering. We also suggest crafting design briefs to highlight co-designed, fit-for-purpose solutions to place-based needs identified by communities to shift from inadvertent deficit narratives toward a strengths-based mindset.

While we focus on a First Nations Australian context, we hope that this work-in-progress piece stimulates reflection on how to center Indigenous value systems, perspectives, sovereignty, and Knowledges in other engineering contexts. We invite readers to reflect on how to challenge stereotypes and deficit narratives in their own contexts and shift to strengths-based approaches that respect and center indigenuity in engineering.

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