Introducing indigenous perspectives on data sovereignty in engineering education

Jesin James and Claire Donald

Faculty of Engineering, The University of Auckland, New Zealand

We live in a data-driven world, and decisions of technology developers impact how the world uses technology. But the education system does not address data sovereignty. This is more relevant in New Zealand, with Māori data sovereignty being a concern. In engineering education, ethical aspects of technology are taught from a western perspective. This paper describes a different approach used recently in an undergraduate engineering course, where an indigenous perspective was integrated with the predominant western view. Electrical and Digital Systems is a course taken by all engineering students at the University of Auckland. This course teaches the engineering perspective on how data is collected and processed, and hence is the perfect point to introduce the indigenous data sovereignty perspectives. Student feedback received so far supports the success of this introduction. This also prepares our future workforce to be competent to incorporate indigenous world views in engineering decisions.

Keywords: electrical engineering, data sovereignty, indigenous perspectives, Māori data

Introduction

> "My data is a living essence, it tells the story genetically about where I've come from, who I am – that's telling a story of me, a story about my whakapapa, right down to my belief."
> - Dickie Farrar, Whakatōhea Māori Trust

Currently, we live in a data-driven world. With the emergence of deep machine learning to develop artificial intelligence-based solutions for many real-life applications, there is a huge demand for more data to train the deep learning models. The word "data" could imply that it is merely vast quantities of numbers such as weather patterns that are input into a mathematical model, and that the model learns patterns from the numbers. But that is not always the case. For example, in order to build speech technology such as speech recognition and text to speech synthesis systems, the "data" that is required are samples of speech and their transcriptions. To build language technology such as automatic email replies, automated answering systems (such as ChatGPT) and grammar checks, the "data" that is required is text in the language in which you want to build the technology. As the hunt for more data continues, it is possible that the ethics of data collection are overlooked. With deep learning models, once the data is used for training, the data contributes to strengthening probabilities of decision trees (in a naïve sense), and it then becomes impossible to trace these decisions back to the data that they were trained on. Ethical data use refers to obtaining permissions for collection data, using the data only for the purposes that permission was granted for, adhering to the data sovereignty principles of the community whose data was collected, and ensuring that the benefits of the data collected reach back to the community. A lot of speech and language data now available on the internet and social media platforms. Hence, it is up to the people involved in the decision-making about data to make sure that the data use is ethical. It is highly likely that these decision makers will often be engineers and scientists who were trained in our universities. In this context, the words of Dr Lorna Williams, Lil'wat First Nation as given below are concerning:

> "So much of the templates, the guidelines, the university courses, have been created along the lines of a colonising language. Our task is to figure out how to be able to speak our languages, how to teach our languages, how to maintain our languages, how to normalise our languages, from our ways, from our perspective, from our point of view."

This paper describes work in progress that aims to embed Māori (the indigenous people of Aotearoa New Zealand) world view into electrical engineering courses. The main contributions of this paper are:
1. A review on engineering education perspectives and indigenous perspectives.
2. A teaching approach that embeds indigenous perspectives in engineering education.
3. A discussion on future pathways to embed indigenous perspectives in engineering education.

The Motivation

The first author's research area is speech and language technology, particularly focusing on low-resource languages, which are languages that do not have sufficient resources such as recorded speech databases, language databases, dictionaries, automatic tools for analysis of speech and language for technology development. The first author's research aims to develop speech and language technology for low-resource languages including indigenous languages such as New Zealand Māori and Cook Islands Māori. The authors of this paper are pākehā (non-Māori) who have had the privilege to be working with Māori who have generously shared their culture so that we could learn and understand the depth of Māori culture. The first author is part of the Speech Research @ UoA Research group that has both Māori and pākehā researchers. The diversity in the group ensures that diverse cultural perspectives are encouraged, discussed and debated. As part of these discussions, Māori data sovereignty and ensuring that data sharing happens in a culturally appropriate way is ensured. The first author's involvement in these discussions and decision making has informed the teaching practice reported in this paper. The Speech Research @ UoA Research group also practices co-development of speech and language technology with Māori, thereby fostering deeper partnerships in the Māori community. The first author along with the research group has had long standing relationships with Te Hiku Media, Kaitaia, New Zealand who are a Māori broadcasting company that maintains strong ties with the Māori community in Northland, New Zealand. The framing of the Kaitiakitanga License mentioned in this paper was pioneered by Te Hiku Media, who then supported the first author in customising it for the various projects they are part of. It is by listening to Te Hiku Media CEO Peter-Lucas Jones' kōrero (discussion) on Māori data sovereignty that the first author was inspired to "spread the word" to engineering students.

Background

The Three Perspectives

Based on the detailed discussion reported in (Kennedy, et al., 2016) on incorporating indigenous world view into engineering education, three perspectives have emerged – the dominant perspective, the indigenous perspective, and the engineering perspective. The dominant perspective is the generally held views of the society, influenced by the factors that impacted the society evolution to its current form. In New Zealand, this culture is a result of the colonization of the country by the British. As in Australia (Kennedy, et al., 2016), the dominant perspective is still based on European thinking, but is strongly influenced by Māori language revitalisation and immigration. The indigenous perspective is the view of the indigenous people of the country, which is Māori in New Zealand. Many writers and scholars describe the differences in the more holistic Māori ways of knowing, a kaupapa Māori, and the implications for education (Hutchings & Lee-Morgan, 2016) particularly decision-making in business, education and scientific enterprise in Aotearoa (Morgan, et al., 2021)(Morgan et al., 2021), which is fundamental in engineering education. Delving into the depth of the differences of these two perspectives is out of the scope of this paper, in which we discuss what data sovereignty means in these perspectives. The engineering perspective has emerged as a result of the graduate attributes for engineering education (from the international engineering accreditation system) which primarily teaches decision-making and problem solving (IEA, 2013). The focus of this perspective is to understand how things work and methods of design to make them work better.

Course Co-Design and Teaching

The engineering perspective is on building speech technology for all languages and using the available speech resources or develop more to build the technology. This perspective is what gets reported in the speech technology development research papers, where the focus is on the process of building the technology.

The dominant perspective focusses on the ownership and licensing of data. Data ownership, from a Western or pākehā (non-Māori) perspective, is decided by who collects data. The ownership rights of the people from whom the data is collected are not defined, except in limited ways of privacy or official information laws (Lee, 2022).

The indigenous (Māori) perspective recognises that Māori data should be subject to Māori governance (Raraunga). Māori regard data as living taonga (unique resource). Hence, Māori exercise rangatiratanga (authority) on the data, and it is essential that the whakapapa (relationship) of the data to the community is managed by maintaining accurate metadata. Individuals and organisations responsible for the data must exercise whanaungatanga (obligations) towards the data, by ensuring kotahitanga (collective benefit) and manaakitanga (reciprocity) and kaitiakitanga (guardianship). Speech and language technology enables computers to understand, analyze, and generate human speech. When working with indigenous language resources collected from communities, our research group prioritizes the data sovereignty of those communities. This intersection of the engineering perspective, dominant perspective, and indigenous perspective inspired my course design from two angles:

Exploring engineering from different perspectives - Engineering education focuses mainly on the engineering perspective in the technical content. Any ethical aspects are often described from a western worldview. Indigenous worldview in less dominant in engineering education. The course design reported here ensures that the students can see the technical engineering perspective, the western perspective, and indigenous perspectives – all informing an engineering design.

Familiarise and normalise an indigenous perspective- Often indigenous worldview is viewed as a separate topic, the details of which are unfamiliar to non-indigenous people. Introducing the indigenous perspective alongside the engineering perspective not only familiarises the students but also makes students comfortable with thinking from different perspectives. Electrical and Digital Systems is a compulsory first year course taken by all engineering students at the University of Auckland, New Zealand. This course teaches the engineering perspective on how data is collected and processed for electrical and computer applications, and hence is the perfect point to introduce indigenous perspectives on data sovereignty.

Current Approaches

In the speech and language technology field, there is growing recognition for the need to decolonize the technology (Bird, 2020). Traditionally, speech and language data were treated as commodities, without involving the communities from which they were collected in the technology development process. Consequently, the benefits derived from the technology often did not circulate back to the community that shared their data. To address this issue, there is a strong push to engage in co-designing these technologies with communities (Bird, 2020). Initiatives to include indigenous perspectives in engineering education have been undertaken, such as the University of Wollongong researchers' efforts to incorporate aboriginal perspectives into engineering curricula (Kennedy, et al., 2016) (Leigh, 2014) in Australia. The Australian Government's Department of Education has also released a report on integrating indigenous perspectives into engineering education (Tom Goldfinch, 2016), providing a guidance framework for curriculum development that incorporates Australian aboriginal perspectives. The report presents five recommendations, including formalized long-term engagements between engineering faculties and indigenous groups, support for establishing connections with indigenous community groups, integration of indigenous perspectives beyond participation targets, dissemination of successful initiatives, and further research on how indigenous perspectives shape engineering practices and outcomes. The University of Manitoba in Canada has reported initiatives where an indigenous Elder spoke to students in a Technology, Society, and the Future course, resulting in increased student interest in learning more about Indigenous Peoples in Canada (Kilada, 2021). This demonstrates the impact of incorporating indigenous perspectives in engineering courses. At Griffith University, the academic team has been working on integrating indigenous perspectives into engineering curriculum design, with initiatives like Engineers Without Borders encouraging culturally aware design solutions to engineering problems (Griffith, 2022). Research indicates that in-class discussions, presentations, real-world case studies, industry engagement, and dialogues with indigenous people benefit first-year engineering students in understanding indigenous world views. Swinburne University has made progress in embedding indigenous knowledge in the Bachelor of Engineering Practice course through the Engineering Practice Academy, emphasizing personal connections with indigenous culture and country in Melbourne, Australia (Turner, 2018). The authors emphasize the non-linear nature of this process, requiring flexibility, reflexivity, and relationality, which differ from Western perspectives of course planning. In New Zealand, the University of Canterbury designed a final-year engineering degree project that integrates Māori worldview and engineering, focusing on water, sanitation, and landscape management issues in the coastal community of Koukourārata (Hughes, 2018). Students had the opportunity to engage with the community, facilitating the co-creation of engineering solutions supported by Māori perspectives. Another paper examines research capacity from a Māori perspective in New Zealand, noting that research institutions at the macro level have been receptive to Māori worldview. This is not reflected at the individual level due to the underrepresentation of Māori in science, engineering, and mathematics (Ruckstuhl, 2019). The paper discusses initiatives by the Science for Technology and Innovation Challenge to address this disparity. While similar initiatives are taking place in various New Zealand universities, currently there is no known focus on data sovereignty.

Methods

The course design's primary goal was to integrate indigenous data sovereignty and ethics with engineering perspectives early in students' education. Typically, data ethics is taught separately from technical content in tertiary-level engineering education, suggesting it can be addressed separately in their careers. However, integrating data sovereignty and ethics with technical content highlights the importance of practicing these values during technology development. Developers should be mindful of ethical implications at each stage. Introducing data sovereignty alongside technical content aims to foster a shift in students' thinking processes. The course

design drew inspiration from the university's current strategic plan (Reference added after review). These guiding documents emphasize the importance of innovating contemporary, distributed, and secure knowledge systems as a means of creating an impact. Our university becoming a Māori data sovereignty organisation is a progression expected due to this impact. Introducing Māori data sovereignty intertwined into first-year engineering supports the goals of our university's strategic plan (UoA, 2022). The education principles to guide course design reported here was based on initiatives to incorporate aboriginal knowledge conducted in Australia (Kennedy, et al., 2016; Tom Goldfinch, 2016). The principles of Māori data sovereignty needed to prepare the course were incorporated from what is outlined by Te Mana Raraunga (Raraunga). Data sovereignty was introduced in Electrical and Digital Systems course in 2021 and continued in 2022, with class sizes of 1086 and 1041 respectively. In 2021, data sovereignty was introduced through student discussions and quizzes. The technical content covered during lectures focused on the collection and digitization of speech data (electrical signals). The discussion began with the lecturer highlighting that once data is digitized, it becomes a series of 1s and 0s. The following two questions and options were presented to students through an online polling system:

Question	Answer Options
You have collected speech data from a group of people speaking a particular language or with a particular ethnicity or from a particular region. As the engineer, you have actually organised for this data to be collected. Who owns this data?	o You (representing the engineering company) o The people who shared the data with you o The engineering company that builds technology with it o Bound by data sovereignty principles of the community o Both community and engineering company
Once the data is collected from the community, the engineering company builds speech technology using it. Who should the technology benefit?	o The people who shared the data with you o The engineering company that builds technology with it o Bound by data sovereignty principles of the community o Both community and engineering company

The answer options were not marked as right or wrong, rather the responses were used to initiate a discussion that led to data sovereignty. There were follow-up questions from students that came as a result of these discussions. Inspired by the discussions that these questions sparked, a section of data sovereignty (prepared in consultation with our kaiārahi – Māori advisor) specifically focussed on Māori data sovereignty was introduced to the coursebook in 2022. Significant time was spent during one lecture discussing how Māori view data as taonga (treasure), and how technology developers should be the kaitiaki (guardians) of the data. A shift in attitude from ownership of data to the guardianship of the data was introduced using speech and language data as an example. This ensures that discussions of data sovereignty are now intertwined into the teaching of the technical concepts and not something to be considered separately in ethics-related course topics. Also, introducing this concept early in the students' engineering studies impacts their view of data ownership and management, and its implications.

Impact

The short-term impact is a shift in students' mindset regarding data sovereignty, recognizing it as an integral part of their engineering decisions rather than a separate concept handled by an ethics committee. This shift became evident during post-quiz discussions, where students actively participated and expressed interest in understanding the rights of companies over collected data. Students enthusiastically engaged in conversations about data ownership and the importance of acting as guardians rather than owners of data. Although specific feedback on data sovereignty discussions and quizzes was not collected, student responses in course evaluations highlighted the impact. Unsolicited feedback received included:

> "I personally enjoyed the lecturer's mention during one of the lectures about the ethics of data collection; it let me consider engineering not just as a process with quantities but rather something that has substantial consequences which we personally need to consider. This encouraged me to pay more attention to the lectures."

This is just one example. It suggests the beginning of a possible shift in students' thinking about guardianship of indigenous data. The long-term impact of this activity is to prepare our students to be the workforce of tomorrow, where they are prepared to make engineering decisions co-designed with an indigenous worldview.

Conclusion and Future Pathways

This paper outlines our initial efforts to integrate Māori data sovereignty principles into a first-year electrical

engineering course. In today's technology-driven era, the acquisition of large amounts of data is crucial for technological advancements. However, the ethical responsibilities of data sovereignty often receive inadequate attention due to a lack of training among engineers and scientists in the ethical aspects of data collection. This is especially significant for indigenous language users, who should have ownership over their speech and language data to ensure that the positive impacts of technological progress benefit their communities. To address this, we have included Māori data sovereignty principles in a first-year electrical engineering course that explores the digitization of electrical signals, including speech signals. This integration was achieved through class quizzes, discussions, and the inclusion of data sovereignty principles in the course content. This attempt is still under development. The section in the coursebook on data sovereignty will now be improved with examples from research groups and industry that incorporate these principles in practice. Industry experts that champion Māori world view in practice will be invited for talks, leading to a group discussion among the students. This will be followed by the lecturer summarising the material in the coursebook. Specific feedback on their views on introducing Māori data sovereignty in the engineering course will be collected from students. Data sovereignty concepts can be easily integrated into second, third, and fourth-year electrical, computer systems, and software engineering courses. Courses like digital signal processing, machine learning, and those involving data collection provide a straightforward opportunity for integration. In other courses, there is room to incorporate perspectives such as sustainability, which is already being done. Furthermore, students can be encouraged to consider indigenous world views when designing industry and research projects during their fourth year.

Acknowledgements

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