Decolonising Computer Science Education: A Global Perspective

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ABSTRACT

There is an increasing recognition that computing education and the profession of computing has failed indigenous learners around the world. In this paper we argue for a reform of tertiary education's computing curricula so that they address the needs of both indigenous and non-indigenous learners. To achieve this, we must first consider the role of computing as a negative colonising force that continues to the present. This paper integrates traditional methods of storytelling to provide context for a reframing of computing as a decolonising force. A case study of the New Zealand context where Māori have been underserved by both computing education and the computing profession, is used to identify systemic barriers. We propose a process of partnership that empowers indigenous communities to work with industry and education to imagine a computing profession that positively contributes to thriving decolonised practice. And then how can computer science education contribute to that? We then canvas some potential directions a transformation of computing education might take. This paper is not intended to replace or pre-empt partnerships or indigenous self-determination, but to inspire computer science educators towards developing an approach that improves outcomes for all learners.

CCS CONCEPTS

• Social and professional topics → Computer science education; Model curricula.

KEYWORDS: Indigenous, Computer Science, Education, Decolonise, Curriculum

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Positioning

Mawera (Kai Tahu, Kati Mamoe, Waitaha) has come to academia through a life of service to people, community and computing. Mawera uses pūrākau (story telling) as an indigenous ethnographic method for recording and protecting lived experience and knowledge.

Sam was raised in Cornwall, United Kingdom, before arriving in New Zealand age 12. He helped lead a previous national review of computing qualifications and is aware of the missed potential in that process.

Alison (Tainui) was one of the first computing graduates in New Zealand. She is a leader in CSEd having developed curricula at local, national and international levels.

Sherlock hails from Guyana, and worked in IT roles across multiple international organisations. He advocates for inclusiveness in computing, and has demonstrated the value of diversity in his research, teaching and service roles.

Dhammika (Dave) was born in Sri Lanka where he learned various disciplines in business management and has hired computing staff in several multi-national companies across South-East Asia.

Stating one's own positioning is a fundamental starting point for many Indigenous cultures and this cannot be relegated to a "bio" at the end. We honour that here. For all of us on a decolonisation journey we must acknowledge our own privilege and complicity, particularly those who represent colonisers.

In this paper we are aware of the careful line we tread. In exploring the curricula implications of decolonising forces applied to computing we are not trying to prescribe the curriculum, and most importantly, we are not trying to circumvent doing it properly in partnership. We're several steps before the stage of developing curriculum, taking a respectful design approach to trying to nudge a process into one that honours Indigeneity.

1 INTRODUCTION

There are many calls for decolonising approaches to education [1]. In describing a clash of ideologies, Maringe et al. [2] argue that current curriculum in the Global South is a replica of what is taught in the Global North, with little, if any relevance to the requirements of development in the local context. While much progress has been made, the STEM subjects

have lagged behind [3]. There is very little prior research on decolonising Computer Science Education (CSEd), and little guidance as to a way forward for decolonising CSEd (note we are using CS here to represent the "meta-discipline" of computing [4]).

While decolonisation can be considered globally [5], it is of course, a process that is both repeated and unique in every colonised territory. It is clearly not possible or sensible to attempt to include them all, so we use CSEd in New Zealand as an illustrative example throughout this paper before attempting to lift to a global perspective. We fully acknowledge that we will miss subtleties and perspectives from other colonised people, but we can only hope that it is useful in a wider conversation.

1.1 Recognition that CSEd has failed Māori

New Zealand was colonised by the British and in 1840 a Treaty – "te Tiriti" in te reo Māori (Māori language) was signed with tangata whenua – the indigenous people of the land now referred to as Māori. Though much contested, te Tiriti promised partnership, participation, protection, kawanatanga (governance) and the privileges of citizenship such as education.

The New Zealand Government is developing a series of Industry Transformation Plans, including computing [6]. As part of that work, a taskforce produced a Digital Skills and Talent Plan [7]. Recommendation five concerns Māori: "Māori to be a crucial partner in skills…A recognition that the current system has failed Māori."

To remedy this failure, there needs to be significant changes in the way the digital technology sector skills pathways are designed and services delivered [7]. The report [7] has a useful career pipeline model - of both education and industry - that shows that the percentage of Māori reduces from seemingly enthusiastic engagement at intermediate school to a low 4% of CS professionals (17% overall population) and even lower in highly skilled and leadership roles [8], and the engagement in the computing industry is even lower for Māori women. This is, of course, not all Māori - our authors include highly qualified wahine Māori (women) computing practitioners.

A reform of tertiary education in New Zealand has resulted in a single institution for vocational education: Te Pūkenga. In this context, vocational education is career focused education at all pre-degree, degree, and postgraduate levels including doctoral level study. This new organisation is tasked with unifying education programmes nationally, with a view to addressing challenges faced by vulnerable groups – Māori in particular [9]. This paper adopts the premise that the CS career pipeline has failed Māori, and asks what, in the light of Te Pūkenga's moves to a transformational unified curriculum, might be done about it? We then return to a global perspective.

1.2 Why decolonise the curriculum?

Mkansi describes decolonising education as a "baffling endeavour" for hard sciences [10]. This bafflement can be imagined in a perspective that things Māori have nothing to do with learning how to write efficient code or implement network protocols (for example). This systemic shortcoming is mostly not from a position of arrogance but a genuine bewilderment of how you could teach a thing that is seemingly culturally-independent and abstract in ways that better align with te ao Māori (the Māori world). We simply do not have models of practice to lean on here. In discussing frameworks to support science and innovation, Ruckstuhl et al. [11] observes that "there is no template on how to bring Māori issues (kaupapa), processes (tikanga), and knowledge (matauranga) into rapidly developing high tech domains".

It is likely that an outcome of transformation and unification will be a te reo Māori (Māori language) version of each qualification and "mainstream" English version. A "Social Report" [12] found that while 55% of Māori reported they could speak more than a few words or phrases in te reo Māori, for only 23% was this "very well" or "fairly well". So, it would be a mistake to rely solely on a te reo version to carry the load here, the mainstream version has to decolonise too.

There are several aspects to creating an educational experience that is more "welcoming". In keeping with Ka Hikitia, the Māori Education Strategy [13] and Te Kura Tapa Whā [14], learning experiences that have appropriate tikanga and kawa (protocols), being "by Māori for Māori", ako (teaching as learning) pedagogies, and having appropriate support (financial and learning) should make a difference. But the focus in this paper is on the design and content of the curriculum.

The first step in curriculum development is to understand the profession we are producing graduates for, and how it relates to wider communities and environments. The inequities for Māori continue into the profession, but beyond even these low statistics, we see inequities persist in access to services, a continuing neo-imperialism of the multinational such as Facebook, and complicity in conspiracy beliefs within marginalised groups [15]. But the concept of computing as a colonising force is underexplored and there is little guidance as to what "decolonised computing" might look like - or even just computing as a positive force in decolonisation. So, the nature of computing as a colonising force must first be considered.

We are then asking people to imagine a computing profession that positively contributes to thriving decolonised communities – in New Zealand's case, to a thriving Titiri-based Aotearoa. Only then can we ask how education can contribute to that? The intention is to inform global discussions around the relationship between Indigenous peoples and computing. The "we" in the first half of this paragraph is our small bicultural partnership, we hope that the "we" in the rest of the journey is a much wider partnership.

2 COMPUTING AS A COLONISING FORCE

Computers weren't invented when New Zealand's te Tiriti was signed. This is not to say that both parties did not have complex information structures - both cultures had intricate (but different) representations of information for navigation, for instance. But the computer as we know it did not appear until the 1940s, emerging as a tool for government and business in the 1960s, and ordinary people from the 1980s. So how can it be a coloniser?

Toyama [16] wrote that technology amplifies human forces, and, we argue, the dominant force in New Zealand was, and continues to be, colonialism. Our almost romantic vision of settler families arriving in tall ships belies the establishment of systems to benefit the coloniser. Crucially, it involves a set of unequal relationships between the colonial power and the colony, and between the colonists—or colonisers— and the indigenous population—or colonised. Systems are imposed that benefit the coloniser. And those forces and systems have continued [17], and are amplified by the computer.

Dourish and Mainwaring [18] wrote of "ubicomp's colonial impulse". Their ubiquitous computing is the notion of computing being everywhere, not in the sense of thousands of tiny computers, but in the sense of pervading all our systems - everything we do is mediated by the requirement to reduce it to data. Such ubiquity comes with the continued domination of a centre with presumption that the periphery needs to "develop". This centre might be either an actual place - San Jose say - or a metaphorical technological centre. There is also a presumption of a need for innovation - that there is a problem that needs fixing - and only the technological centre has the imagination and agency to do so. With the idea that the technologists are, in some sense, typical people; the problems that we encounter now are the problems that everyone will have soon.

Thus, technology comes with an homogenising assumption, a one size fits all, but that size was created by and for someone else with little concern or understanding of local requirements. Worse, the "logic of lack" denies agency to develop solutions, and "to put technology to use in (one's) own context and develop own meanings in complex, messy and multifaceted contexts of everyday practice". Further, the technologists are positioned as "plain folks" who happen to be in privileged positions of being advanced technologically, so in seeing problems as their own, the problems to be solved are those of technology. And everyone is a user of technology or will be soon: "it allows no position other than 'user' or 'non-user' as the reference point for understanding people and their contexts". And such context becomes moot when imposed solutions are of universality and quantification.

In short, if technology doesn't make things better for you, then there is something wrong with you, your education and your cultural understandings, not the technology.

So far, we have two interrelated forms of colonisation. First, the structural colonialism of the state and organisation, creating structures and processes to the benefit of the system. And second, the technological colonialism, imposing universal logic and encoded solutions.

The interaction here is multiplicative, not additive. The interaction increases the likelihood and impact of either - Reitsma et al. [19] write of design, and the logic holds here: "The use of design within the context of indigenous communities raises concerns. This has to do with the characteristics of design to 'improve' lives and its emphasis on innovation". And it happens faster, and at scale. As Taiuru [20] describes, "(as we) move from the physical world of inherited bias and unconscious racism to now being applied to the digital ecosystem. The issue with the digital ecosystem is that the impacts are exponentially faster and the consequences are mammoth".

Beyond enabling colonising systems, we also need to examine the impact of the design of computing itself. Nasser [21] describes how the "public butchering of non-Latin text" is a "deeply hurtful reminder to every Arabic reader that the digital world was not built for them, and that their culture is an afterthought at best". This is damaging, "English-centric assumptions ran deep enough to color not only my present, but also my imagination for different futures".

Nimal is the 12-year-old, eldest child of a family that lives near Colombo. Nimal's dad doesn't get much work. His mum works as a supervisor in a garment manufacturing plant. Mum started as a machine operator and progressed to the current job. She is the bread winner of the family.

Nimal is doing well in the classroom; he learns in their language - Sinhala. One day, he wants to become an Engineer. He is good in maths. His teacher said computers are the future. So, he also learned computer as a subject.

Schools closed with the outbreak of COVID-19, and then came the countrywide protests. Every day, they hear something bad is happening in Colombo. Nimal thought "how I am going to study? Mum says if I don't study, I will not be able to provide for the family. He heard this talk about online learning and extra help seems like a "good idea". Some of the important subjects like Mathematics and Science are taught on YouTube channels.

"Mum, can we buy a computer?" Nimal asked. "Let's see" Mum replied. Next week Mum came back with not so good news. "Looks like we cannot afford one. They are so expensive… Fuel prices are going up again… food prices are already up…" There seems to be many reasons why we can't buy one. There was little hope, and this bothered Nimal. How am I going to study now?

One day, they received an overseas call, from Nimal's aunty Samantha who lives in United States. Aunty and Mum talked about computers. Weeks passed; Nimal finished reading books he borrowed from the library. Most of them are in Sinhala. Schools are still closed.

One sunny morning, a delivery man brought a parcel, Dad signed on the piece of paper they gave, and opened the parcel. "A computer!". It was a laptop. A note inside the parcel said its from their aunty. Nimal felt so happy. It was the happiest day. It smells so good, so, refreshing, new and exciting.

Nimal opened the computer. It is now connected to internet through his mum's mobile hot spot. At least he can use it when Mum is at home. He opened Google and typed all his problems. Nimal saw a new challenge. The answers seem to be there, he needs to know English better to understand them. He remembers his grandma saying, "life is full of challenges". A new challenge. English!

But, one might argue, surely most of computing is independent of culture, algorithms are abstract sequences of instruction devoid of value statements, similarly networks are merely complicated switches and cables - and there are strong biases encouraging that view [22]. But, taking a Freirean view [23], this apparent lack of values exposes the normalisation of the oppressive culture. Artefacts are actively imbued with the political values held by those who created them [24], these values silence other values [25], and knowledges are not innocent [26]. Writing of Industrial Design, Torreta and Reitsma [19] argue that it "emerged from a specific nature/culture and political situation; it is therefore a situated field that echoes the worldview of where it was created". In computing's terms, an apparent lack of values does not mean technology is benign, rather that we have come to presume that efficiency, speed and productivity are values that match societal aspirations.

Yet, it would be foolish to throw the baby out with the bathwater. Even in describing the dangers of artificial intelligence that fails to account for te ao Māori, Taiuru [20] argues that "digital technologies have a key role to play in advancing solutions to complex areas affecting Māori".

Joseph Selwyn Te Rito [27] credits Sir Apirana Ngata for encouraging Māori to embrace the pen "te rākau ā te Pākehā" (the stick or tool of the Europeans) as a useful tool for recording whakapapa (genealogy) to hold on to their culture for their emotional well-being. He described the pen as a:

> "new technology for their physical well-being; and to acknowledge the spiritual creator for their spiritual well-being… In the 1800s, Māori people grasped the writing 'stick' and proceeded to write whakapapa down. Today, the new 'stick' is the computer."

Or, is there no modernity without colonialism? [28] Te Rito's perspective contrasts with those who say the pen was the end of a centuries-old oral tradition and the loss of mana for those who shared the stories.

Taiuru [20] describes his first forays into professional computing in the late 90s "...but at the time CS was frowned upon by many kaumatua (elders) and the very few Māori who were in the industry at the time". This, he argues, is because of the link between computing and authority, and it continues today, "Māori are already suspicious of the government due to colonialism, oppression and intergenerational trauma, which makes Māori susceptible to belief in conspiracy theories" [15].

These biases held within indigenous communities can be seen to be part of wider systems of bias and intersectionalities. For instance, in a study that examined the role of females in one of the largest open communities that support software development Stack Overflow, it was observed that particular male contributors used language that was deemed to be discouraging to female participation [29]. Across cultures and geographically this pattern persists, with contributors from the USA for instance tending to possess the highest influence (reputation), but demonstrating the highest degree of individualism and being least open to others [30].

I first arrived to study for an IT qualification where an educator at a learning institution was discussing various "advanced applications" in a lecture. While

being shy to contribute at first, with encouragement responses were provided in relation to a number of mobile data and voice solutions that were at the edge of the telecommunication spectrum" at the time. I looked different to my classmates. The educator asked about my country of origin, which when given, they replied. "oh, that is the reason". During subsequent follow up conversations after the lecture ended the educator noted that they "...were of the perception that the author was from a particular continent, and so was surprised that they had such contemporary knowledge". Thus, "...knowing that they were from a more developed area, the work made sense, in terms of the responses they were able to provide". Such events fuel the legacy of distrust, but also cement the view that decolonisation is necessary, but will require significant willingness from all stakeholders.

3 DECOLONISING COMPUTING

Is it sensible to demand that computing honour te Tiriti? As we said earlier, modern computing technology didn't exist in 1840. While not explicitly about computing, the Waitangi Tribunal Claim 776 - that of allocation of radio spectrum, is useful here. The Tribunal found that the Treaty "was not intended to fossilise the status quo" and is "a living instrument to be applied in the light of developing circumstances" [31].

Māori expected, in signing te Tiriti, that European colonisation "would allow them to share the benefits, including the technologies, of those peoples" [31]. This sharing "must be a real sharing, in which Māori participate as owners and managers, possibly in joint partnerships, and not merely as consumers". This finding combines with the earlier rulings that the government must use broadcasting assets for the revitalisation of te reo Māori [32]. If we extend that logic to computing, Māori can expect that they share in the benefits of the new technology, and the government is responsible for using it to benefit Māori in so far as it is able through systems of education, as producers not just consumers - and it must do so in real partnership.

This sets the blueprint for curricula reform in digital education. It is useful for us to go beyond this procedural argument and consider what decolonised computing might look like, and then what this might mean for vocational computing education.

There is a deep and growing literature in decolonisation [17], what might this tell us about decolonising computing?

In a global context, Betts [5] described how the concept of decolonisation formed from a political phenomenon of the 1960s with the creation of self-governing states, which "soon extended to all elements in the colonial experience political, economic, cultural or psychological". This process is of course complicated by the continuing forces of colonialism, and particularly, that of the intertwining of development and modernisation.

Rashied and Bhamjee [33] asked what the Global South needs to do to decolonise the fourth Industrial Revolution. All the Industrial Revolutions can be seen as colonising, including the computational 3rd IR and the 4th IR with greater integration of physical, mechanical and digital systems. The effect of this digital integration has been to further reinforce the inherent colonial nature of industrialisation upon wider and deeper aspects of society and the environment. For Rashied and Bhamjee the answer is to identify a post-development ideology that enhances (or at least doesn't sacrifice) value systems, sovereignty and diversity, and then to cultivate a digital environment to enable that.

Tuck and Yang [34] warn us to avoid the mistake of using decolonisation as a metaphor for human rights and social justice, but demands an indigenous framework, land sovereignty and indigenous ways of thinking.

Sherwood and Anthony [35] describe a strengths-based approach to Indigenous ethics, arguing that "Indigenous people should not be classified as a disempowered vulnerable people but as an empowered yet oppressed peoples through Western constructs situated within colonial structures".

Using this strengths-based approach that respects and accepts that Indigenous people are experts in their lives and knowledges, we can look to Māori successes in computing. The first Digital Strategy [36] identified "Māori Digital Practitioners" as being fundamental to New Zealand's continued prosperity. Unfortunately, as Weatherall et al. [37] described, only a handful of such practitioners could be identified - hardly enough to base an economic strategy. Now, 17 years later there are 700 people contributing to a group of Māori Digital Practitioners [38]. The current Industry Transformation Plan [6] uses "Māori Digital Ecosystem" in a similar sense, and there are wonderful examples of organisations operating at the sweet spot of culture, technology, and business.

In this framing we need to focus beyond the negative critique of constructions of cultural difference, but on the productive possibilities of the seams among differences [39]. These seams are where we need to be looking for our curriculum. Philip challenged us to "to critically interrogate techno-deterministic objects and systems through a sensitivity to difference in culture, power, history, politics, knowledge, and practices in all their complexity and diversity". So, we return to the question posed by the baffled CSEd practitioner 'but I teach students to write code, what does this have to do with me?'

Karaitiana Taiuru [20] has long worked in CS. Most recently he was advising a medical school on te ao Māori implications of genome research. He has explored extensively the implications of Māori data sovereignty, Internet of Things, and social media [38]. Just taking the example of Atamai Iahiko (artificial intelligence) provides many examples and guidelines of practice. One is left wondering how anyone could do AI without matauranga Māori. Asked if the same rich understanding might be found if he were to turn his eye to other areas of computing - networks, databases - his reply is "absolutely, we've just started" [38]. Indeed, some areas of computing have had this richer treatment: social media [40] and spatial technologies [41] are useful examples.

In a small, isolated rural community, in the hills of the Bay of Plenty region of Aotearoa, a boy was afraid. The Boy loved school. He loved learning, being with his mates, his teacher, catching the bus, eating lunch, drawing, reading books, and everything about school. He was smart and school was the best thing in his life. But he did not like doing anything on computers. Koro (grandfather) told him that computers are a waste of time, and the internet was bad. He had lived with Koro since he was born, and Koro was old and old people know heaps of stuff. Now "The Covit" was trying to kill the people, so he was not allowed to go to school. Even worse, Teacher had told him he had to use a Chromebook to do schoolwork at home and he knew Koro would not like that. Stupid Covit!

Teacher knew there were going to be challenges for The Boy using his Chromebook at home. Koro was her uncle, and she knew how he felt about technology. He was old-school. He was brought up at the feet of his own Koro, attending hui (meetings), learning tikanga and te reo Māori. Koro's generation had fought against colonisation to hold onto their identity. He had been forced to attend a Native School where he was punished for speaking his own language and forced to speak English. Forced to learn ways of being that were not his. Forced to learn the skills to do a job he would never do, working for Farmer so that Farmer could farm the land that was stolen from Koro's family. Koro would only ever see computers as the modern Native School. Stupid Covid-19!

"Kao (no), Girl, I am not having that thing in my house, said Koro. Get rid of it! Don't you know about a 5G that is spreading The Covit. I'm not having a 5G here, making us sick". "But Uncle, The Boy needs it to learn. School is closing the doors, but the government says the tamariki (children) still have to go to learn." "Learn, Girl? What do you mean by learn? Are you saying

that what I know and what I learned from our ancestors does not matter as much as your technology?

4 CURRICULUM DEVELOPMENT

In attempting to decolonise the 4th Industrial Revolution, Maringe [2] sets out high level principles for decolonising curriculum development. The second of these principles (the first is about a critical visioning process) is that "there are no cross-disciplinary hierarchies of knowledge". Decolonisation of curriculum therefore involves collaborative knowledge creation rather than the exclusion of other forms of knowledge.

The New Zealand re/development of the school (K12) CS curricula into two Digital Technologies and Hangarau Matahiko (DT/HM, [42, 43]) curricula is useful for scene-setting. Crucially, as a first observation, it is not a direct translation. For example, while the English version puts technical intervention first, the te reo version "begins with the Māori world and its relevance to the changing world. They must also focus on the values, skills, and technical knowledge of the world they are familiar with" [43].

Second, we observe that this subtle difference in philosophy is played out in a different structure. The English language DT focusses on computational thinking and developing digital outcomes. For the te Reo version, two new curriculum areas within HM focus first on te reo and tikanga, digital citizenship and computational thinking - a focus on understanding the past to inform the future, and connecting traditional Māori practices and knowledge with contemporary skills.

The third observation we make is that the English DT curriculum and its delivery is also informed by matauranga Māori. The redevelopment was aided by the resources developed based on the legend of how Maui brought fire to the world, and in particular the relationship between Maui and his kuia (grandmother) Mahuika. The characteristics of each were drawn as qualities needed for innovators of change, and encouraged ākonga (students) and kaiako (teachers) to move from being consumers to innovators of change by utilising these qualities, for example the curiosity of Maui and the patience of Mahuika.

We see this as an example of what Stein [44] describes as "taught by difference". This entails de-centering and suspending preconceptions about the 'other' to open up to being taught by difference and thus, to unexpected and potential disruptive rearrangements of knowing, being and desiring".

A potential barrier to a decolonised CS curriculum is a perceived lack of space, a feeling that "we can't fit Indigenous material into a schedule that's already full of core computing". But, we argue, this would be the wrong way of looking at it. Bennett [45] uses the term "Anupholesteraphobia" - the fear of not being able to cover all the material. Rather than something to cram into an already overcrowded curriculum, we can take from Bennett the approach of seeing Indigenous knowledge as the context for computing, a basis for deeper learning, or even a reason for learning. As Ruckstuhl et al. [11] argued, the integration of Indigenous knowledge with technology usually quickly arrives at the summit of both.

5 A WAY FORWARD

This is not a conclusion, but a vision of an island over the horizon [46]. We have a clear need to decolonise the CSEd curriculum. This will improve the outcomes for Indigenous communities and for a richer computing profession. This decolonisation needs to be done by the Indigenous communities themselves led by Indigenous CS and CSEd practitioners, with assistance, where requested, from allies within the wider CSEd and CS communities.

As a large global computing professional association ACM is cognizant of the need to recognise the many different cultures of the world. More than 50% of its members are non-USA residents. It has also recently created a Diversity, Equity and Inclusion Council to address many of these needs. The recent ACM/IEEE Computing Curricula report, CC2020 [4], as a global computing curricula report, recognises indigenous communities and diversity. In section 6.5.3 on Cultural Sensitivity and Diversity the report states "universal acceptance of global diversity is essential in all fields of endeavour, particularly in the computing field that is so diverse." It further recognised the need for adaption of curricula by indigenous communities, "it is important to be aware that cultural similarities and differences do exist between people and the computing programs they represent".

Even with these steps towards attempting to achieve diversity, equity and inclusion, the question of the role of ACM, however, is somewhat fraught. There is a clear tension between global structures and Indigenous communities having the power for self-determination. Writing of academic power structures, Maringe [2] argues "decolonising decoloniality provides the most formidable problem in the transformation processes". It is about "shifting power bases from large global players…a feat nearly impossible by small local players".

So, we suggest the ACM embark first on a process of engaging Indigenous communities to envision the nature of any partnership. This will require humble design [47], radical listening [19] and acknowledging position and privilege. These partnerships can then begin the process of curriculum development. We need to enter this process with the expectation and appreciation that the outcome will be different than if it wasn't a partnership.

We believe the subsequent step will be one of collaborative speculation [48], or as Farias refers "social dreaming together" [49], as to the decolonising role of CS. While this should be strengths-based rather than deficit framed, the narrative will undoubtedly include narrative engagement with trauma and the role CS has played in that. CS needs to be prepared to accept that it has failed Indigenous communities.

The decolonised role of the CS professional can then be used to develop graduate outcome statements for qualifications, and then through constructive alignment, courses be developed. It is crucial that we be prepared for outcomes that add to understandings of CS (see [20]), but for the possibility of wholly different epistemologies and ontologies of CS - we need to accept the legitimacy of multiple ways of knowing. We see a likely pathway whereby specialised Indigenous CS qualifications are developed. This does not excuse the mainstream curricula from adopting decolonising frameworks.

In this paper we described initial required work towards a vision of decolonised CSEd internationally. Karetai et al. [50] gives specific recommendations for the New Zealand computing curriculum development process.

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