Mobile app development: Work-integrated learning collaborations with Māori and Fijian partners

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Only a few information and communication technology (ICT) work-integrated learning (WIL) projects involving universities and Indigenous partners are being reported and very little is known about the approaches that are followed. This article reports on successful student work placements in Indigenous communities when co-developing software for the community. We provide two case studies of projects which involved work-integrated learning students and researchers from a university, as well as researchers and practitioners from Indigenous communities in New Zealand and Fiji. Two independent app development projects were the central focus of the collaborations with these two communities including placement students. The article describes the learning and insights from these WIL projects and provides recommendations for creating successful WIL opportunities with Indigenous communities.

Keywords: WIL, ICT, Indigenous communities, Māori, Fiji, mobile app, interstitial space

This article reports on two case studies of student work placements in Indigenous communities in which software for the community is being co-developed. The two projects involved students and researchers from a university, as well as researchers and practitioners from Indigenous communities in New Zealand and Fiji. Differing from typical work-integrated learning (WIL) projects, where a placement partner may have a predefined placement agreement for specific work, these WIL projects were larger and more open in their scope.

As in many other colonized countries, the nature of education and work in New Zealand is typically defined from the perspective of the colonizer. Colonizing systems perpetuate the privileging of Western thinking as the favored, or only way, of perceiving the world. The values of Indigenous cultures are often at conflict with those of the dominant culture (Macfarlane, 2012). Learning activities are similarly defined by dominant cultural contexts. Culturally-competent projects need to respect the self-determination of Indigenous communities with their culture, knowledge, tradition, and values (Arbour & Cook, 2006). When exploring how Māori and Tauiwi (non-Māori New Zealanders) may authentically undertake research, Cram and Phillips (2012) suggests the concept of 'interstitial space', in which both sides can authentically partner. Within such spaces, each partner can bring their (cultural and disciplinary) backgrounds, and space is given to explore how these complement and challenge one another. In this paper, we explore WIL collaborations with Indigenous partners in light of this concept.

The driving force behind the projects were the two communities' desires for cultural revitalization through the means of modern information technology. In both projects, questions of data ownership

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and guardianship had to be addressed through the software design, data-collection methods, and means of data access and protection. The Indigenous communities approached the academics with the goal of developing information and communication technology (ICT) solutions that supported the celebration of their cultural heritage and knowledge. The WIL projects were shaped around the needs of the communities, supported by academic staff.

Very few WIL collaborations with Indigenous partners on ICT projects have been reported (Franquesa et al., 2012; Tsai et al., 2013). The case studies presented in this article describe projects relating to the co-design and development of two mobile apps. The Waiata app (co-developed with Whakatōhea Iwi) collects and teaches traditional Māori songs and hymns to their local iwi (tribe). The iCavuti app (co-developed with the Ministry of Fijian Affairs) provides a digital platform allowing visitors to search for traditional location-based Fijian acknowledgements which play a critical role in cultural practice. Both projects had champions from within the communities to support and uphold the collaboration with the university partner. The placement of WIL students supported such close collaboration between academics and the Indigenous community. The students spent parts of their placements within the Indigenous community and acted as intermediaries for questions of local concerns regarding the project, co-design, data collection, and implementation.

Within each case study presented in this article, we describe the Indigenous partners' background and the relevance of the project for the community. We thus aim to assist the reader in understanding how the collaboration developed before the WIL placement opportunities were identified. We then give a brief overview of the ICT project, before describing in detail the students' work-integrated learning and the unique features of these placements. One of the students (S1) involved in our WIL placements had a paid internship working with the Indigenous community; the three other students (S2, S3, S4) were enrolled in courses that received study credit. This article aims to answer the question: what are critical success factors for work placements in ICT projects that are co-developed with Indigenous communities? The article concludes with 16 recommendations for creating successful WIL opportunities with Indigenous communities.

BACKGROUND AND RELATED WORK

This section discusses the background information and related work on work-integrated learning with communities, typical software engineering processes, and software development with Indigenous partners.

Work Integrated-Learning and Information Communication Technology

WIL programs at their core acknowledge the importance of learning through experience. Many higher education institutions embed WIL as part of their degree programs, providing students with work experience and opportunities to test their theoretical knowledge in new situations, supporting reflection and learning. The benefits of WIL programs in the context of ICT degrees are recognized for students as well as stakeholders, partner organizations and universities (Pilgrim, 2011). A major focus is often on the learning of 'softer' skills, such as teamwork, self-management and initiative, that are highly valued by employers.

WIL programs may take many different forms, such as paid/unpaid, full/part-time, endorsed formal course work or complementary to studies (Smith et al., 2009). Groenwald et al. (2011) identify four types of WIL programs:

1. Professional practice, for example, apprenticeship, internship, professional practicum;
2. Field and industry programs, for example, intercalation in medicine, sandwich year for students (Brooks & Youngson, 2016);
3. Community/Service focus, also called service learning or community-based learning; and
4. Other WIL opportunities, such as teaching or research assistantships, work-study, work exchanges.

Of particular relevance for our case studies is Groenwald et al.'s (2011) WIL program with a community focus (item 3 above), often called service learning. Its focus is typically on community needs (Liu & Lin, 2017), often relating to civic responsibility (Sanderson & Vollmar, 2000) or volunteer work (Patricia, 2011). Conversely, service learning in ICT contexts merges the use of technical skills with communication and problem-solving skills in a community context (Ohashi & Yamachi, 2017). Service learning in the ICT discipline is relatively young given the age of the discipline. In typical service learning settings, the majority of community partners are not-for-profit organizations (Sanderson & Vollmar, 2000; Patricia, 2011; Ohashi & Yamachi, 2017; Davis & Rebelsky, 2019), such as public libraries, retirement homes, and secondary schools. Reasons for those placements being sought are limited funding availability, lack of expertise in the area of need, and an overall dependency on volunteers. Thus, most traditional service-learning activities are carried out within local communities and are driven by known community needs.

WIL programs in the ICT sector predominantly focus on placements with industry partners. However, ICT is no longer merely an economical sector but permeates all layers of society. Based on a review of WIL models related to the ICT/digital industry, Siddoo et al. (2018) concluded that many ICT WIL models lack applicability to the ICT sector as aspects of digital literacy and digital cross-sector collaboration are missing. Example programs and types of projects in the ICT sector are:

a) Computer literacy, for example, in after-school programs (Ohashi & Yamachi, 2017), senior citizens or low-income groups (Shulman et al., 2002);
b) Coding camps in high schools (Banerjee & Mazur, 2018);
c) Co-designing health-related information technology (Tsai et al., 2013);
d) Website evaluation and design for not-for-profit organizations (Franquesa et al., 2012; Patricia, 2011; Winschiers-Theophilus et al., 2015); and
e) Database applications, e.g., for membership management in community groups (Carter, 2011; Sanderson & Vollmar, 2000),

We note two types of service learning activities in the ICT sector: educational support that does not necessarily rely on the students' advanced ICT capabilities (project types (a) and (b)), and professional services that are more technically challenging, (project types (c) to (e)). For tertiary institutions, visibility and impact in the local community are often of value. The students involved in such placements described it as "rewarding to know that they are making software that others will use and that will benefit [their] community", and organizers similarly observed that "the focus on local community is particularly motivating to our students" (Davis & Rebelsky, 2019, p. 30).

Software Development Processes

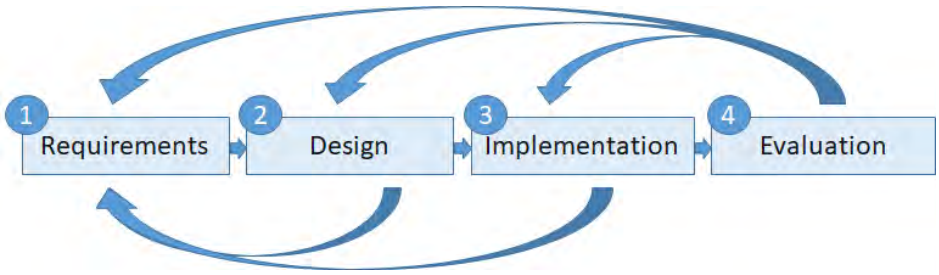
As our WIL placements involved software development activities, we briefly describe here the software engineering process. The design of software is not a linear process. It typically follows a series of iterative steps, which may have to be revisited as the project progresses. In a typical software

engineering process, there are four main categories of activities (Figure 1); each may consist of several iterations and feedback loops:

1. Requirements analysis: gathering of requirements and expectations for the software, including functional (expected software function) and non-functional aspects (ease-of-use);
2. Design of the software: deciding on the main functionalities and interaction elements;
3. Implementation: programming of the software and development of user interfaces; and
4. Evaluation: exploration of the software with end-users.

The extent of user involvement that occurs within each of these categories is dependent on the design and development methodology being followed. User-centered design (Norman & Draper, 1986) will typically involve users in Steps 1, 2 and 4 above, whereas co-design (Sanders & Stappers, 2008) involves users in all four steps.

FIGURE 1: Four steps in typical software engineering processes, with feedback and iterations.



Very little has been written about software co-development with Indigenous communities, and of those available publications, most report on specific projects. Here we describe three of those projects. While these do not involve WIL programs, they are closest to our own work.

The first project was a collaboration between researchers from Singapore, Malaysia and New Zealand, in partnership with Penan people of Malaysian Borneo (Plimmer et al., 2015). The focus was on developing an app for language learning using tangible objects. A field-based design process was used, blending ethnography with other participatory approaches. Before engaging in the project design, permission by the village headman was sought by the research team. The engagement followed cultural protocols based on the existing community relationship that one of the researchers held. The Indigenous community determined the schedule of research interactions, was closely involved in requirements gathering and prototype evaluation based on agreed protocols. Our second example is the OL@-OR@ project (Te Morenga et al., 2018), where the development team used a Kaupapa Māori (agreed Māori principles) co-design process for developing a mobile health app. Their overall process was based on Māori values and cultural norms and included explicit relationship-building before exploring the prototype design space and joint concept exploration with focus groups. As it came to implementing the prototype, designers were briefed to include Māori imagery, and an "uncluttered, simple design aesthetic" (p.96). The evaluation was carried out with Māori communities and triggered further prototype iterations. The third example is the iNethi project, which co-designed a community-owned wireless network in two under-resourced communities in Cape Town, South Africa to support local content sharing (Lorini et al., 2018). The project team aimed to avoid overemphasis of researcher needs, and instead to maintain a firm focus on the community's needs. It was agreed to not pre-design the development of the project before the deployment, but rather to follow a participatory and reflective methodology. The project began with a series of reflective workshops involving interested community

members and the university, which led to the establishment of a governing board for the project. An Acceptable Use Policy was developed and shared between interested parties. In a co-design manner, the Wi-Fi infrastructure was built and local services developed. One of the central philosophies of the iNethi project was to give space to different types of expressions and ecologies.

As shown across these examples, most community-focused collaborations of Tauiwi and Māori in New Zealand seem to focus on health interventions (Harding et al., 2021; Kidd et al., 2021). However, technology aspects are rare. While none of the three projects incorporated WIL aspects, we note relevant themes in the engagement with Indigenous communities, such as respecting the community's time and processes, participatory approaches, and listening to community feedback and reflection. We now present our two case studies of WIL projects in which software for the community is being co-developed, and explore the process of setting up and maintaining collaborative relationships.

CASE STUDY 1: WAIATA MOBILE APP

This collaboration investigated the preservation of Māori knowledge using a digital library and mobile app. Our project partners, the Whakatōhea Iwi are the tangata whenua (Indigenous people) from the Eastern part of New Zealand. Their Te Ihi Ka Roa ICT programme was initiated to develop Whakatōhea's digital literacy, capability and capacity. Specifically, we worked with the Whakatōhea Māori Trust Board, which was established in 1952, with the purpose of managing Whakatōhea assets for the benefit of its members. It aims to nurture Whakatōhea reo (language), culture and identity, and their importance in building the iwi's wellbeing.

The Whakatōhea Iwi is based in the Ōpōtiki district (Eastern Bay of Plenty) on the north island of New Zealand. The iwi's ancestry can be linked back to the Mataatua canoe, which bore the female ancestor Muriwai from Hawaiki. Muriwai's daughter Hine-i-kauia went to Ōpōtiki and married Tūtāmure. The descendants of this union became Te Whakatōhea, who later merged with Te Panenehu. The iwi currently has six main hapū (sub-tribes), comprising approximately 15,000 registered members.

Project Background

A collaboration was started between co-author Alvin Yeo (School of Computing WIL Liaison) and the Whakatōhea Iwi in 2016. This collaboration was originally facilitated through introductions provided by Maui Hudson, an academic colleague from Whakatōhea. This partnership led to other collaboration and outreach activities involving the School. Through conversations following these meetings, the project idea for the Waiata app was created by the iwi. This collaboration aimed to develop a mobile phone app in which the Whakatōhea Iwi could preserve the iwi's traditional waiata (songs) for their community. Waiata are traditional songs, chants, lullabies, and laments that communicate and preserve cultural and historical teachings.

Whakatōhea Iwi wished to develop the waiata app as a technology-based means to teach the Whakatōhea history through waiata, and as an opportunity for the iwi to learn about app development. Uniquely, the app has both a public-facing section with a limited number of waiata for interested users who are not a part of this iwi as well as a password protected collection for the community themselves.

Māori Partner

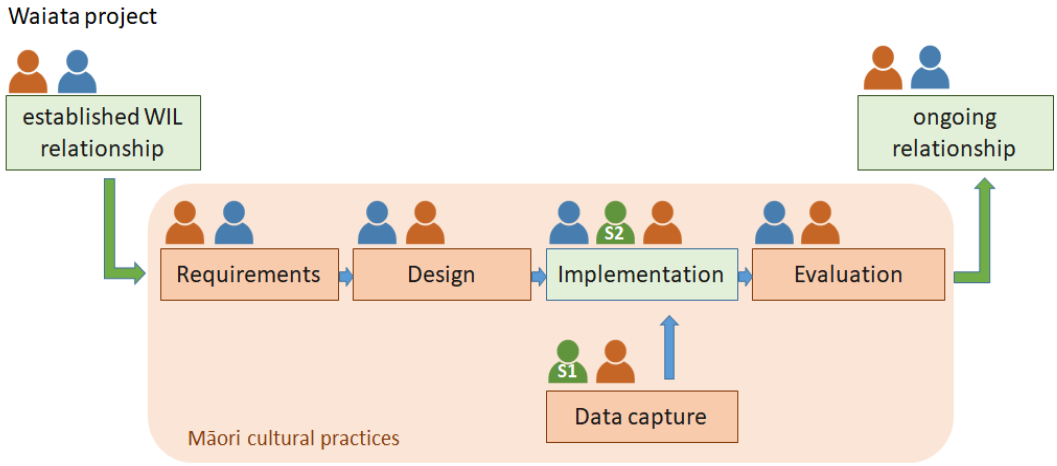
The contact person for the Māori project is co-author Danny Paruru, the Iwi Development Manager for Te Whakatōhea Māori Trust Board and also from the Whakatōhea Iwi. The Māori partner was the main

point of contact for the University. Other iwi members involved in the co-design process and the collection of waiata included Anita Kurei-Paruru, Rangimarie Biddle, and Tangiahua Churchward. Before the project commencement, the Research and Archive Trust, guardians of the iwi's knowledge and taonga (treasure), and the kaumatua (elder) were consulted. One of the central concerns for the iwi was to retain data sovereignty, that is, full governance and control of their own culturally relevant data.

Project Collaboration

The foundations for this project were laid throughout the previous years when the School of Computing at the University of Waikato first began collaborating with Whakatōhea Iwi. In 2016, Whakatōhea Iwi began building their own local digital hub (Te Ihi Ka Roa) at Ōpōtiki, for which the School of Computing gave technology support after having been invited by a University of Waikato colleague from Ōpōtiki. Student ambassadors from the computing department visited the *iwi* and worked with intermediate and high school students on robotics workshops, and other outreach activities. Also, through student placements, the School also supported developing teaching material for Te Ihi Ka Roa (see top left in Figure 2).

FIGURE 2: WIL activities in Waiata Project as an extension of software engineering processes (red person: community partner, blue person: university partner, green person: WIL student).



In 2019, Alvin Yeo invited academic Annika Hinze to give a presentation about her research on mobile app development at Te Ihi Ka Roa. At that meeting, Danny Paruru shared the plans and goals of Whakatōhea Iwi for building a digital future for the rangatah*i* (the younger generation) of the iwi. The initial concept for the waiata app was discussed, with the goal of both developing an app for the iwi to use, and throughout the collaborative process, for iwi members to build the capability of developing mobile apps. In particular, the project aim was to learn how to develop mobile apps such that this knowledge may then be shared at Te Ihi Ka Roa with the local youth.

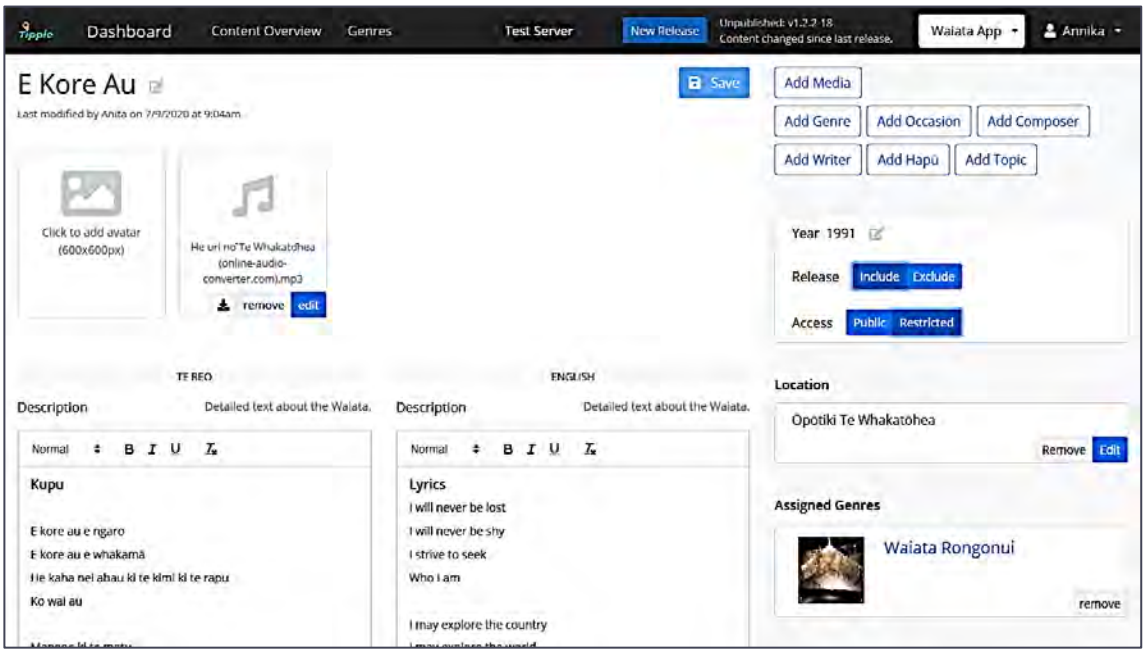
Two WIL students were brought into the project team at this point: one of them (Student S1 in Figure 2) was placed at Ōpōtiki to support iwi members in the collection of waiata and management of the technological challenges. This student is of Māori descent, but not from the Whakatōhea Iwi. The second student (S2 in Figure 2) was directly involved in the programming of the mobile app and data storage, and was predominantly situated at the University. This student was an international student

from China. Throughout, the team had face-to-face meetings with iwi members in Ōpōtiki and via Zoom. Parts of these meetings were about whakawhanaungatanga (trust and relationship building) as new team members joined the ongoing project.

The co-design process of the app involved several members of the local community. They described to the team how they imagined the waiata app to work, and initially, an interface mockup was produced by the University researchers, including Nicholas Vanderschantz a design researcher. Throughout several meetings, the community group gave feedback and explained how they felt about the prototype or if it needed changing.

One of the first project parts to be made available to Whakatōhea was the dashboard to upload waiata details and recordings. Figure 3 shows the final incarnation of the dashboard, which was adjusted and developed further depending on the community's needs.

FIGURE 3: Dashboard with content for Waiata app.

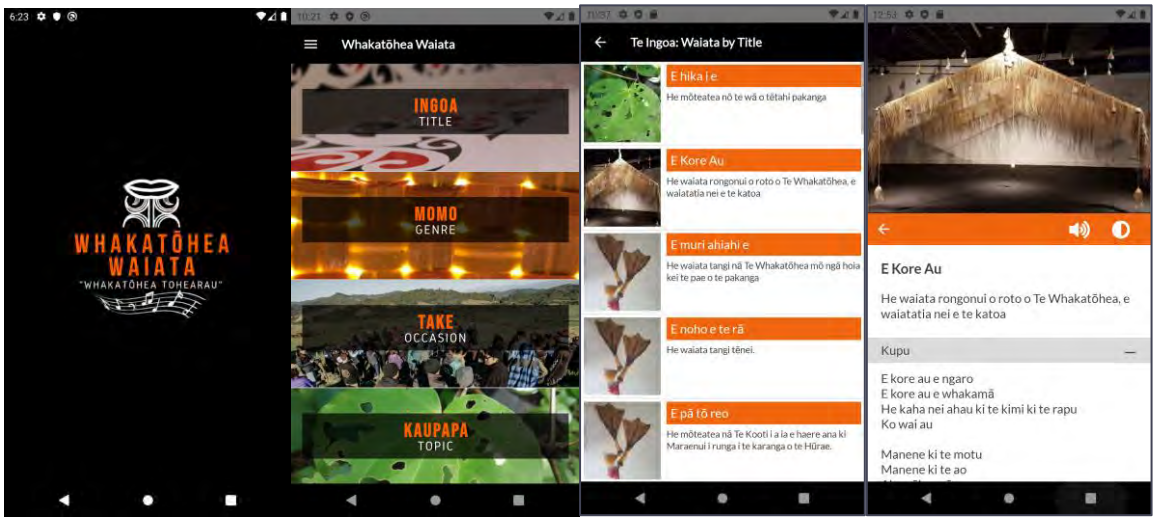


Alongside the development of the dashboard, the mobile app was developed. A local designer in Ōpōtiki, Rangimarie Biddle, (who also works at Te Ihi Ka Roa as a community educator) proposed a logo for the app, which is rooted in the history and traditions of Muriwai. Figure 4 (left) shows the logo on the app's splash page. This design represents the iwi's tipuna (ancestor) 'Muriwai' as the name of the iwi 'Whakatōhea' is derived from her characteristics. The upper graphic symbolizes Muriwai's Te Waha me te Moko Kauae (chin tattoo) and the app colors (black, orange and white) were chosen as these are specific to the iwi but not to any of the six hapū (subtribes).

Figure 4 (middle and right) shows selected parts of the app interface, which correspond with the waiata shown in the dashboard (Figure 3): the Menu page gives options to select waiata based on title, genre, occasion and topic (Figure 4, second from left). The Waiata by Title list (third from left) shows all waiata by their title with a short description and an icon that relates to the waiata genre. Finally, the Waiata page (Figure 4, right) shows the lyrics and explanations (including a language changer and the audio option). In addition to the app, all waiata are also included in an iwi-owned and co-designed digital

library to preserve the heritage information for further studies. This is a related project that was carried out in collaboration with a University team.

FIGURE 4:App interface with content prepared with the help of the WIL student.



Work Integrated-Learning Student Experience

While both WIL students worked closely with the University team and the iwi group, they had different linkages to the wider WIL group. The programming student (S2 in Figure 2) was connected to a cohort of WIL students and was also placed within a research lab at the University. She joined the team on car trips to Ōpōtiki (a road trip of about four hours), and at the end of the project, was invited to stay for a weekend in Ōpōtiki and join a household in which a large wedding was being held. This type of WIL engagement with local Indigenous communities required the student to embrace another culture and ways of doing things, not merely in a work context but to bring their whole person to the relationship.

The second student (S1 in Figure 2), who was placed directly with the iwi, was involved much closer in the life of the iwi throughout his project. He resided for the time of his placement with one of the Whakatōhea families in Ōpōtiki. His work arrangements were more loosely defined and involved technology support, tuition, content co-creation, as well as participation in the daily life of the community. He thus embodied the principle of he kanohi kitea - being a known face (see discussion Section 5.2).

Both students developed technical and interpersonal skills relevant to working in a multicultural environment. This project provided a stepping-stone for the WIL students for employment in industry or community settings. The interactions during the project were not of a short term or casual nature (as one may assume for an industry placement) but rather were understood to be part of building lasting relationships.

CASE STUDY 2: FIJIAN MOBILE APP ICAVUTI

This collaboration investigated cultural and traditional knowledge preservation using digital information and a mobile app. iTaukei are the Indigenous people of Fiji. iTaukei identity is critically linked to vanua (this use; 'land', also 'culture', 'people') connections associated with ancestry. The term

for that connection is icavuti. This collaboration aimed to develop a mobile phone app which provides easy access to the cavuti repository and assist users to identify the correct cavuti for the place they are visiting.

Project Background

iTaukei, Indigenous Fijians, do not think of themselves as belonging to a nation or conversely as individuals, but instead identify as members of their paternal (primarily) and maternal (secondary) tribe or clan and the vanua that tribe or clan is connected to (Ratuva, 2007; Ravuvu, 1987). The term for that affiliation and connection is icavuti, which implies 'belong to'.

When visiting a Fijian village or house (including the home of an expatriate), and/or when making speeches or presentations together with gift exchanges and services, the cavuti of those present are mentioned (Lealea, 2015). This is necessary and critical to appropriate cultural practice. This protocol has similarities to Māori powhiri or whakatau, a formality used to eliminate tapu, or 'separateness', between host and guest (Aporosa & Forde, 2019).

With each chiefly entity in Fiji having their own cavuti, this has led to several thousand na i cavuti. Additionally, these are based on ancestral titles and pre-colonial place names. Therefore, in some cases, cavut*i* can be quite lengthy, and not easy to identify or memorize. Moreover, the misuse or mistaken use of cavuti is deemed careless and in some instances, disrespectful, reducing mana (spiritual power/significance) and in turn efficacy, during the presentation or cultural practice being undertaken (Brison, 2001; Tuwere, 2002).

Traditionally, Fiji was an oral culture, with important traditional knowledge such as icavuti memorized (Shaiza et al., 2016). However, the increased use of written records is weakening remembered knowledge, such as icavuti. Textualized cavuti records are scarce and difficult to access, therefore, beliefs that it is no longer necessary to memorize cavuti are based on idealized assumptions as opposed to established knowledge. Moreover, reliance upon non-existent textualized cavuti is increasingly leading to this important acknowledgement process being miss-presented and in some cases negated, resulting in culturally inappropriate practice and the loss of critical traditional knowledge.

The app also links to a local initiative, the Tabana ni Vosa kei iTovo Vakaviti (Department of Language and Culture) established by the Tabacakacaka iTaukei, or Ministry of Fijian Affairs. The Tabana is a subdivision of the Tabacakacaka iTaukei and mandated with safeguarding iTaukei culture and heritage (Ministry of Information, National Archives & Library Services, 2010, p.1). Over the past ten years, the Tabana has been conducting cultural mapping which includes the collecting and recording of oral traditional knowledge including na i cavuti (Ministry of iTaukei Affairs, 2017). This collection of cavuti served as the basis for the mobile app developed in collaboration with the Tabana who is an Indigenous partner in the project.

Fijian Partner

The contact person for the Fijian project partner was co-author Aporosa (cavuti: sucu i Niusiladi, vasu ni koro i Naduri, Macuata [literally meaning born in New Zealand and maternally related to the village of Naduri in Macuata, Fiji]), who is an academic at the University of Waikato. Following the completion of the cavuti data collection and verification exercise, Aporosa approached a contact at Tabana ni Vosa kei iTovo Vakaviti and invited them to partner with the University of Waikato in the development of a mobile application aimed at providing readily available icavuti via both a text or map-based searchable

platform. Aporosa worked with the Tabana in the early 2000s and has maintained ongoing relationships. An important first step was the affirming of relational connections between the University of Waikato and Tabana ni Vosa kei iTovo Vakaviti which included seeking permission to both develop an app focused on an aspect of iTaukei culture and to use the cavuti data. That priority was driven by the understanding of mana and itovo vakavanua (correct protocols). In a similar manner to the discussion above linking the misuse or mistaken use of cavuti with disrespect and disruption to mana, misuse of icavuti, e.g., its use in a mobile application without first seeking appropriate authority to use the data, could also result in negative consequences through the "cursing [of] offending parties" (Aporosa & Forde, 2019, p.77).

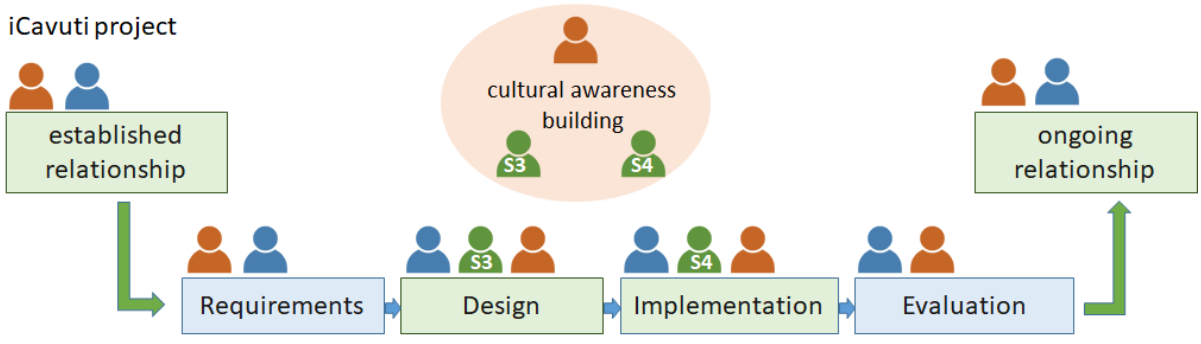
Additionally, while the Tabana ni Vosa kei iTovo Vakaviti collected the cavuti data, they maintain a custodian role over that knowledge bank as opposed to ownership, with each individual cavuti remaining the property of its specific tribe or clans who, as stated above, 'belong to' both their vanua and their cavuti (Tuwere, 2002). Therefore, we prioritized the seeking of appropriate permissions and the establishment of lines of accountability and cultural boundaries to ensure compliance with itovo vakavanua and the expression of mana in a "positive capacity" (Marett, 1914, p.112) to aid both the protection of the app developers and the success of the project.

Project Collaboration

The project began with Aporosa (the project contact) approaching the School of Computing regarding a possible joint app development project (see top left in Figure 5). The collaboration started with the computing team (still without the WIL students) learning about the cultural background and requirements for the project. The basic app interactions were defined and a list of necessary functions were outlined. Based on these requirements, the necessary team roles were identified. It was decided to offer two WIL projects: one design project and one programming project.

In the next step, a design student was brought into the project team as a WIL placement (see S3 in Figure 5). This student is Tauiwi. The team had a number of face-to-face meetings with the project contact, to learn about the itovo vakavanua linked to icavuti and to understand the relevance of the project.

FIGURE 5: WIL activities in iCavuti Project as extension of software engineering processes (red person: community partner, blue person: university partner, green person: WIL student).



As cavuti plays a critical role in formal ceremonies and cultural practice, the student designer (S3) was invited by the project partner to a kava ceremony (see top middle in Figure 5). Kava is a tropical

Oceanic plant and drink made from the plant, with great significance to Pacific peoples (Aporosa, 2019). At the kava use venue, the student designer saw kava being mixed and presented, a protocol underpinned by icavuti, which provided a practical, yet authentic, demonstration and understanding of cavuti use, together with engaging mana and cultural protocols to aid the success of the project. The designer then went on to have project meetings with the computing team and/or the project partner. This design process was more closely integrated than a typical software engineering design process, and the client had more responsibility than typically expected.

Supported by meetings, conversations and feedback, the student developed an interface design prototype for the icavuti app. The front pages of the app are presented in both vosa vakabau (Fijian language) and English, accessed alternatively by a language switching toggle. The main cavuti data is in vosa vakabau as it is intended for a Fijian audience (native and expatriate). Figure 6 shows the complexity of interaction and information flow within the app.

FIGURE 6: Complexity of interactions between pages on iCavuti app.

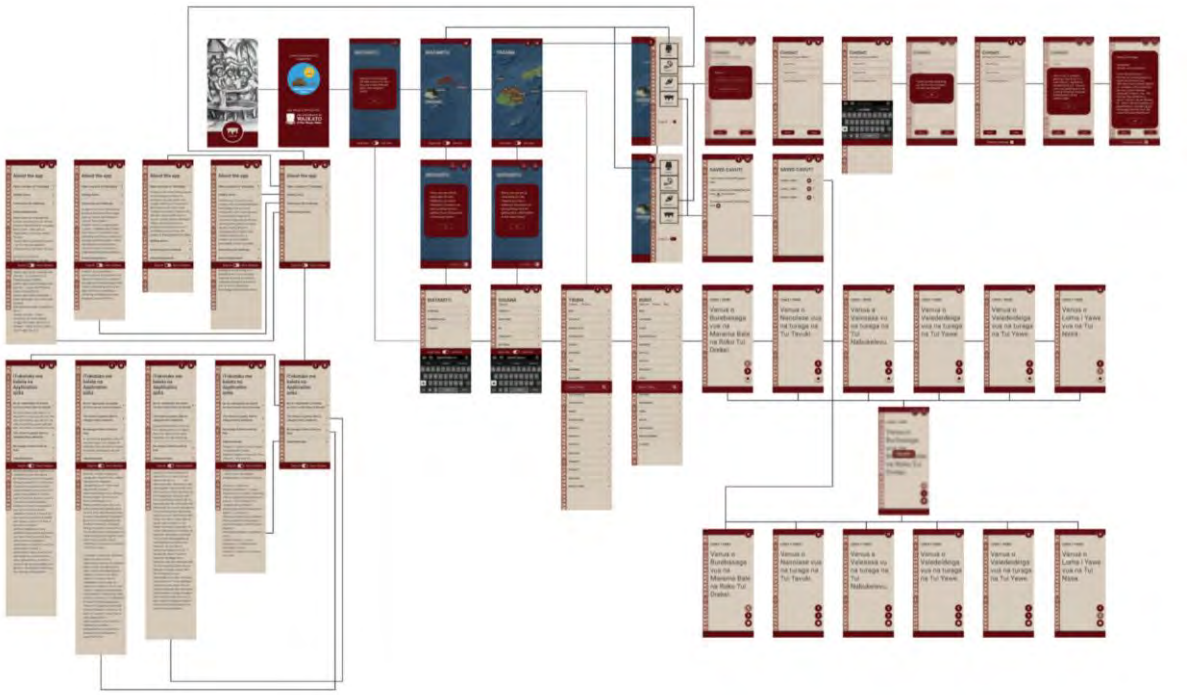
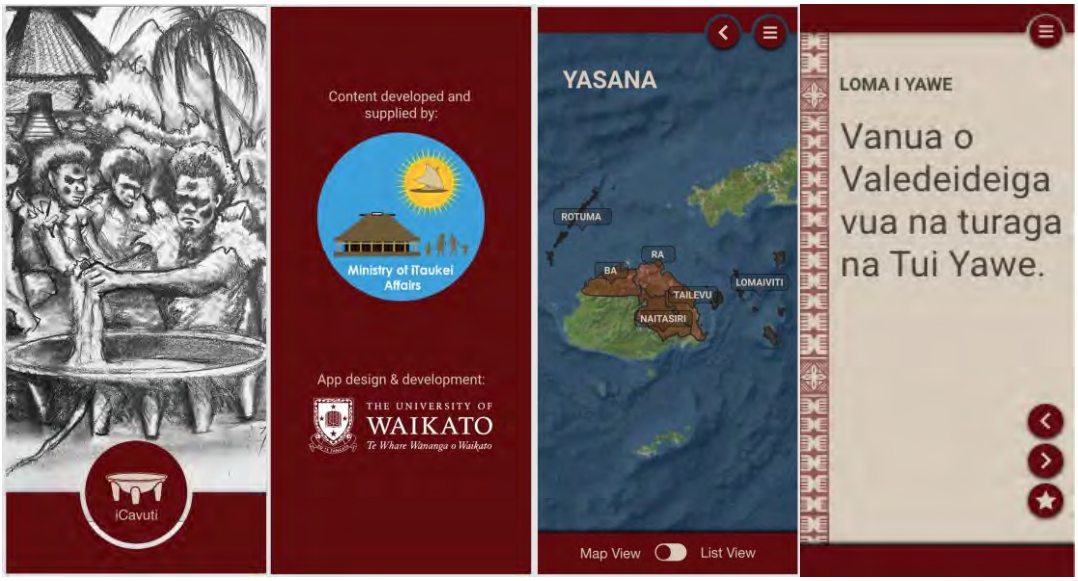


Figure 7 shows selected parts of the app interface: the design mockups for the landing page, splash page, map and a cavuti page. The app implementation involved a second WIL student (S4 in Figure 5): a programmer who coded the design into an interactive mobile app. This student was from Vanuatu. As the student joined the team, he met up with the design student and the project team to learn about the intended project. The student programmer was also invited by the project partner to a kava ceremony, again serving to develop cultural understanding and compliance with the protocol. The programmer also continued with regular project meetings with either or both the computing team, and the project partner and the designer.

Work Integrated-Learning Student Experience

While both WIL students worked closely with the project team and the contact person, they were also embedded in a cohort of WIL students. Within their cohort, regular reports needed to be provided, in addition to reflections about the project and the project team. The design student (S3 in Figure 5) was loosely embedded into the larger cohort, and presentations about the project were only given at the end of the placement. For this, the student created a poster and presented it at a conference-style meeting that was open to the wider public. The computing student (S4 in Figure 5) belonged to a small WIL cohort, which held weekly meetings with students and supervisors. Each student presented their work via zoom, showing their programmed interfaces and discussing project progress. At the end of the placement, the student wrote a report and presented the project in an internal conference.

FIGURE 7: Parts of the app interface mockup by WIL student.



Both students developed key skills for use in human-computer interaction, information systems, and graphic design practice. This project offered to the students the experience of being involved in a real-world project with deadlines and other project-related obligations. Uniquely, the students had the opportunity to work with an Indigenous partner and learned about the cultural processes involved in collaborative development work that differs from traditional industry placements. Unfortunately, given the context of a global pandemic, an in-person community engagement has not been possible. Cultural awareness building and community participation was central for both the students and academics and happened alongside the software engineering process facilitated by Apo Aporosa (see Figure 5).

DISCUSSION

The lessons learned from the case studies are compared with those reported in related work literature, and with the established processes from software engineering. The lens of interstitial spaces (Cram & Phillips, 2012) is also used to explore the interactions of the placement partners, and the students involved.

Lessons Learned and Reflections

The two WIL projects expanded on the traditional software engineering processes, as discussed above. Here the project timelines are set out and the lessons learned are analyzed.

In both the projects, the relationships between the University and the Indigenous partners were already established. Building trust between the partners before commencing the WIL project is essential and has been discussed for other ICT co-design projects (Lorini et al., 2018; Te Morenga, 2018). Building long-term relationships and trust does take time that is better measured in years than months. Only when mutual trust is established are projects able to move forward; it requires both parties benefitting from the collaboration (Arbour & Cook, 2006), and parties to deliver what they promise. Winschiers-Theophilus et al. (2015) warns in this context about 'white elephant' projects in which 'foreign' technology is imported into the community, tested, and ultimately ignored because the true needs of the community were not considered. In the case studies, both parties respected each other or each other's strengths and valued each other's contributions.

In the case studies, the established relationships enabled the researchers to bring WIL students (and other researchers) into the collaboration without the need for long relationship-building activities. The researchers, in this case, can be seen as gatekeepers (Winschiers-Theophilus et al., 2015), researchers that are selected by the community to act as a proxy of the community to liaise with incoming researchers and students. The trust placed in the gatekeeper then is transferred onto the other guests, with the understanding/expectation that the gatekeeper does 'the right thing', that is, bringing the right people to move the project forward and have the community's needs in mind. The cultural competence of the researchers helped ensure the projects were successful. Each of the researchers had several years of experience in working with Indigenous communities (e.g., more than 20 years for the gatekeeper). The level of cultural competence and trust in the gatekeeper must be sufficiently high to allow other people to be brought in. As it is the responsibility of the gatekeeper to ensure that the student is prepared, the WIL students were screened (through observation and an interview process) before allowing any of them to join the projects.

A further factor contributing to the success of the projects was the experience and expertise of the community point of contact. The community partners acted as local champions (Yeo et al., 2006), providing motivation and insights with a deep understanding of the local community. In our case, the community partners did not only have knowledge of their community but were also experienced community researchers in their own right. For example, Danny Paruru has more than 17 years of experience representing his community, liaising with the community, and applying for funding and conducting research. Apo Aporosa has more than 20 years of experience with the community and conducts research in international development and issues related to Indigenous communities.

For the success of the two projects, it was crucial to have institutional support. Forging and maintaining community relationships is resource-intensive. External research grants typically do not sufficiently acknowledge the need for time and direct cost for community relationships. Therefore, these need strong support from the institution, to ensure such resourcing has priority. In our case, the School of Computing has for a number of years allowed the allocation of resources (e.g., direct financial support, staff time, travel), and supported the establishing of WIL courses, without which such projects would not be able to run.

Both projects presented here were shaped by the needs of the community. Based on the presentation of a researcher's experience with app technology, Whakatōhea Iwi expressed interest and selected its

application in the waiata space. The Fijian app was based on a need by the community (Fijian based and diasporic) brought to the university's attention by Aporosa. As a consequence, the communities not only have a vested interest but also participated actively in shaping the projects.

With the relationship established, both projects were agreed upon rather quickly, as the Indigenous partners knew the researchers would not take advantage of the community. The experience of both researchers and community contributed to the relative ease of starting the projects: each person more or less knew what they needed to do, and knew the scope of their knowledge. For example, there was no kick-off meeting to determine what role each of the collaborators was to play. We believe this was due to the experience of the team. In a less experienced team or a shorter pre-existing relationship, such a delineation of project roles would need to be prepared and agreed upon. For example, in the iNethi project, considerable time was spent on discussing the project philosophy and involvement and roles of each partner (Lorini et al., 2018). Similarly, Winschiers-Theophilus et al. (2015) reports on the need to clarify community roles, such as informants, informed participants, validators or co-researchers. In our case, initial challenges were able to be overcome with relative ease, for example, the local champions helped with details such as getting approval to access Indigenous data.

Because of the trusted relationships, requirements analysis was carried out relatively smoothly. The community partner identified the right people to be involved in the project; for example in the Waiata Project, to talk to the kaumatua (elders) to get approval, their blessing for the project; to the families and the archive, consent to be obtained from the right people. The local champion plays an important role in this phase. The design and implementation were conducted in a collaborative manner, where none of the partners insisted on pre-defined roles. For example, for the design of the Waiata app start screen (see Figure 4, left), typically carried out by the team's design researcher, one of the rangatah*i* (youth), Rangimarie , proposed and carried out a design that incorporated the history and values of the iwi. After a feedback round with researchers and the community, the logo design was included in the final app.

Throughout the project, expectations and requirements were adjusted to community wishes. The ability and willingness of the team to adjust the timeline and goals of the project was crucial to its success, and also constituted one of the most significant differences to the development processes in commercial ICT projects. Typically, requirements are identified and closely tied to financial obligations and timelines. In the icavuti project, the design of the splash screen and of the app interactions was led by the community, including an iTaukei artist. The WIL students and the research team respected the community's domain knowledge (such as cultural protocols). In turn, the community partners recognized the researchers as the technology experts.

Throughout the projects, frequent communication ensured that all partners were on board and informed. Weekly discussions were held during the WIL project via zoom, in addition to face-to-face meetings whenever possible. Both communities showed strong commitment and were actively engaged throughout. Both parties were respectful of each other's time and commitments, as the community partners similar to the research team had many projects and other work commitments outside of the shared projects. All the collaborators freely shared their knowledge, trusting that the other partner would not be taken advantage of. In addition, and perhaps more important for the relationship than the sharing of knowledge, was the sharing of food, kava, arguably the Pacific's most significant traditional substance and other social activities that continually nurtured the relationship. All four WIL students were involved in manaakitanga (hospitality and sharing of food) and kava ceremonies.

For both projects, the work and participation of the WIL students ended at the completion of the trimester. However, the engagement of the University team with the communities is ongoing, and final project steps are still being done (e.g., evaluation of the icavuti app and its launch by Tabana ni Vosa kei iTovo Vakaviti who have invited the project team to Fiji for this) and future projects are already in preparation.

The established relationships are understood by both partners to be of enduring nature, while specific projects may come and go and roles in the projects change over time. It is important for tertiary partners to understand that these relationships are akin to familial relationships, which come with obligations. They require care, time and effort, and should not be taken for granted. These ongoing relationships open opportunities for long-term projects that can accommodate students over multiple semesters (Davis & Rebelsky, 2019). They also allow new ideas to be explored, such as next year's WIL projects on a digital library for Indigenous knowledge.

Work Integrated-Learning Collaboration in an Interstitial Space

Arbour and Cook (2006) call for culturally-competent research and stress that research relationships need to respect the self-determination of Indigenous communities with their culture, knowledge, tradition, and values. Indigenous peoples have their own research principles and ethical practices and are emerging as researchers in their own rights and with their own aspirations (Smith, 1999). We now review our WIL collaborations with Indigenous partners in light of the concept of interstitial space (Cram & Phillips, 2012). In interstitial spaces, partners can bring their authentic selves, including cultural and disciplinary backgrounds. Cram and Phillips (2012) observes that interstitial spaces are vitally important but often overlooked, and therefore under-designed. Doty (1997) as cited in Cram and Phillips (2012) likens interstitial spaces to shorelines in which relations shift both by hour and by season. They require and support the constant negotiation of relationships, allowing for our backgrounds both to complement and to challenge one another.

Gray (2008) and Cram and Phillips (2012) identify as one of the key barriers to culturally-competent research the lack of process skills (e.g., problem-solving, conflict-resolution, and boundary-management). Research principles driven by Indigenous values (Smith, 1999; Cram, 2001) acknowledge the practice aspects of research and have been predominantly used by Indigenous researchers to inform their research practice and ethics. Cram and Phillips (2012) argue that these principles may provide a means to create interstitial spaces that promote cross-cultural collaboration.

These Indigenous research principles are now used as a lens to reflect on the WIL project experience and the responsibilities of the research team.

1. Respect for people/Aroha ki te tangata**:** This value asks each participant to be open to other perspectives, and comfortable with revealing gaps in their own knowledge (Cram & Phillips, 2012). They describe how a linking vision can motivate the team, in our projects this vision was held and communicated by the Indigenous partners. Based on the existing relationships, both parties respect each other for their strengths and expertise and know they can trust that commitments will be honored. The existing trust in each other helped resolve conflicts and adjust expectations during the project. Making time and space for discussions between the community and researchers helped understanding each other's motivations and goals.
2. A known face/He kanohi kitea: This value asks the participant to invest time and commitment into long-term relationships; to be engaged even if there is no immediate personal benefit. One of the placements students (S1) was placed with the iwi, to help with data collection, content

co-creation, and technology support. His stay enabled capacity-building and was an investment into the relationship. Danny Paruru guided the research team when they joined the community in a waka ama race on the river. Similarly, Aporosa met several times with both placement students S3 and S4 beyond the direct needs of the design and implementation: the kava ceremonies and time spent together helped the students make sense of their tasks. Throughout the project, researchers and the community met weekly on zoom, and whenever possible travelled to stay for two or more days in Ōpōtiki with the community.

3. Listening before speaking/Titiro, whakarongo, kōrero**.** This value encourages people to learn first about the community, its contexts and needs, before speaking. It encourages a strength-based perspective (Cram, 2009). Through Alvin Yeo's working with the local champion (Danny Paruru) and the community over a span of several years, the team has gained a reliable guide for its understanding of the community. In addition, many discussions among the research team and with the WIL students helped make sure everyone was on board and was growing in their cultural understanding, without having to take every detail to the community. Working with two community champions (Danny Paruru and Anita Kurei-Paruru) who had years of experience working with research teams also helped manage the research team's need to clarify their understanding.
4. Generosity/Manaaki ki te tangata**:** This value is about giving back to the community, being generous with one's time, training, and providing a koha (a reciprocated gift) (Jones et al., 2006). One of the first WIL placements with Whakatōhea was on developing teaching material for the tech hub Te Ihi Ka Roa. As part of the WIL process described here, student S1 and a staff member provided online tutorials for the community. A group of other students who visited Ōpōtiki this year contributed to the community by painting a fence.
5. Caution/Kia tupato**:** This value is about being considerate in actions and words. There is a potential tension between communities and research/WIL groups regarding timing, as a WIL placement is for one trimester only. Managing expectations on both sides is important. Scoping of the WIL projects was conducted considering the abilities of the students and the time available. For the Waiata app, discussing data rights and access to waiata became central to how the software was designed. The ultimate solution was reached through a number of discussions in which both sides explained their concerns (e.g., protecting the indigenous knowledge of Whakatōhea, and the development team needing access to waiata examples to work with). In the case of the iCavuti Project, caution necessitated appropriate cultural practices (e.g. kava presentation), the seeking of authority and acknowledgments of data ownership; processes if negated, could result in negative consequences at the mana or spiritual level.
6. Respect the dignity of people/Kaua e Takahia Te Mana**:** This value is about the communication and reporting of project findings. Traditional research projects typically took information from Indigenous groups, without communicating the project's findings to the communities (Cram, 2009). In the iCavuti Project, the community champion was closely involved in the design activities of the WIL student. Similarly, the weekly meetings kept the Whakatōhea community informed on any new developments in their app, often communication flowed both ways as part of the data collection, co-design and implementation steps. The findings of the projects were co-presented at local conferences, and the two community champions are co-authors of this article.
7. Humble/Kia Mahaki**:** This value is about empowering the community through research, the focus of which has to be determined by the community itself, and the researchers taking a back seat. The aspiration of Whakatōhea Iwi is to ensure that their history, heritage and *taonga* are

preserved for future generations to help provide educational opportunities for Whakatōhea. In our projects, both groups took the lead in deciding the app's focus, the visual design, and the main functionality. The research team provided technology information to support the decision making and implementation.

Jones et al. (2006) describe how these values can safeguard the research process, as well as the communities, researchers, and research insights. We believe the same holds for WIL projects and students, and that these principles can guide the WIL process to ensure interstitial spaces are being created and protected.

RECOMMENDATIONS

Extending the insights from Yeo et al. (2012; 2006), Tanner and du Toit (2015), and Cram and Phillips (2012), who explore research with Indigenous communities, we provide sixteen recommendations for creating successful WIL opportunities with Indigenous communities:

Pre-Project

1. Institutional support is essential
   WIL projects with Indigenous communities require explicit support from the University because forging and maintaining community relationships is resource-intensive. It is important that the institution provides formal recognition of community-based projects in the WIL context such that the students are not disadvantaged in comparison to industry-based projects.
2. Good relationships are vital and take time to establish
   The Māori principle of *whakawhanaungatanga* (establishing and building relations) covers this recommendation appropriately. It takes time to build strong and trusting relationships. As such, investment in these relationships should not be taken lightly, it may be resource-intensive in the first place but will see returns in the long term.
3. Ensure relationships are mutually beneficial
   Both the University and the community partners should benefit from this partnership as both parties would be more motivated to participate in such projects.
4. Identify a local champion
   The local champion is the intermediary between the community partners and University, is generally held in high esteem and is well connected in the community. He or she is also well-versed in the protocols of the community and knows the community well. The local champion is the go-to person and identifies the sources of information, and also is well connected to the decision-makers in the community.

Starting the Project

5. Relationships are already established before the WIL project starts
   Through established relationships, researchers would, through their interactions with the community, know the needs and priorities of the community. Thus, the appropriate WIL students are triaged appropriately to work on the right community issues, and students can start immediately on the projects.
6. WIL project scope and timeline is agreed before bringing the students into the project
   University semesters tend to be short, as such, the projects should be appropriately scoped and sufficient time allocated. It would be unfair for the students to spend the whole semester

finalizing the scope of the project and not implementing the project (unless the students' project is to do just that, or the student has more time especially in a Master/PhD or research projects).

7. Communities and universities are equal partners in the WIL project.
   The community are equal partners in the WIL projects. Both University and community partners should make decisions and discussions together. Ideally, the project should be community-led, as these projects have greater engagement by the community.
8. Create an interstitial space guided by Indigenous values.
   The project partners need to be able to negotiate their changing relationships, allowing their backgrounds both to complement and to challenge one another. Indigenous research principles provide a means to create interstitial spaces that promote cross-cultural collaboration.
9. Manage expectations of all involved: students, intermediaries, university, community.
   All participants should be aware of the expectations of their roles and know how to fulfil the responsibilities of the role. If they are inexperienced, training should be provided to ensure they gain a certain level of awareness and competency. Relationships take years to build but seconds to destroy -- as much as possible the various groups should be well prepared to work together.

During the Project

10. Follow the community's protocols.
    When working in the community, researchers and WIL students are guests of the community. They should as much as possible, adhere to the protocols and customs of the community, usually on the advice of the local champion.
11. Adapt community-centered co-design and community-based development approaches.
    The approaches used should be community-centered. The participation of the community in the development process is crucial to the success of the projects. The community participation could be in any phase of the development lifecycle, and opportunities to co-design and develop the software opens opportunities for new ideas and solutions (given the meetings of two groups of people with varied skills and knowledge).
12. Roles are clearly defined and assigned.
    By doing this, there would be no misunderstanding of who is doing what and who is responsible. Amongst the role in addition to the student, academic supervisor, community partner, intermediary, local champion, researchers, project manager, and informants.
13. Frequent communication (via multiple channels).
    The communication between the University, WIL student and community partner, is not only important for maintaining the relations but also the smooth running of the project.
14. Share your knowledge, and learn from one another.
    Be generous with your knowledge and learn from them. It is usually through the sharing, discussion and exchange of ideas that new ideas follow.

Post-Project

15. Relationships are ongoing.
    Indigenous cultures appreciate and expect long-term authentic relationships that are honored by all parties involved. These relationships are to be maintained by the researchers, with no formal obligations falling to the WIL students. Once such relationships are forged, they can result in further projects and collaborations that are mutually beneficial.

16. Involve all partners when sharing project insights.
    Co-ownership of any insights gained through the WIL project needs to be acknowledged. One of the ways to achieve this is by the community and the researchers co-authoring and co-presenting through traditional academic outlets as well as appropriate community outlets.

CONCLUSION

This article reports on two successful WIL projects in Indigenous communities when co-developing software for the community. The aim was to provide an understanding of how the WIL collaborations developed and to identify critical success factors for work placements in ICT projects that are co-developed with Indigenous communities. Successful WIL placements involving Indigenous partners in ICT projects benefit all three collaborators: students, universities, and the Indigenous community. We provided sixteen recommendations for creating successful WIL opportunities with Indigenous communities.

The two case studies show that community WIL projects may be time-consuming to set up and supervise, yet the ongoing relationships and benefits provide win-win-win opportunities for the community, the student and the university: the community co-directing an ICT project that is relevant and meaningful for them; the WIL students working with community partners to improve their industry-relevant skills while learning from the community; and researchers contributing to projects that are relevant and have a positive impact.

ACKNOWLEDGEMENTS

We would like to express our gratitude to the community partners involved in both of these collaborative WIL experiences. As is customary with these two cultures we have identified key participants in the projects by name. For the protection of the students involved, we anonymized their identities, however, we sincerely thank these four students for their commitment to these unique WIL experiences and their contributions to the relationships that have been built.

STATEMENT OF PLACE

Alvin YEO Wee (杨威, *Yang Wei*)

My paternal grandfather is Teochew, and my maternal grandparents are Chao'an; originally from south-eastern China. My paternal grandmother is Iban, one of the 28 Indigenous ethnic groups in Sarawak, East Malaysia, on the island of Borneo. Both my parents and I were born in Sarawak. I identify myself as a Teochew, a Sarawakian, and a Malaysian. I was fortunate to grow up and study in a multicultural environment in Sarawak and was given the opportunity to pursue my bachelor's degree and PhD at the University of Waikato. How I engage and interact with Indigenous communities, was shaped by collaborating with my multidisciplinary (notably my Social Science) colleagues, community partners in Sarawak (specifically, the Kelabit and Penan Indigenous communities) and continues to be influenced by the local champions from Te Whakatōhea Iwi. I also acknowledge the support and opportunities afforded by the University of Waikato to pursue my interest in leveraging technology for good.

Annika Hinze

My family is from regions in Europe that are now Germany, Poland, and Russia. I was born in the German Democratic Republic and grew up near Berlin. My university degrees were obtained in the

Federal Republic of Germany, where I received a PhD in Computer Science. I now call Aotearoa New Zealand my home, I am Tauiwi and identify as Tangata Tiriti. E mihi ana ki ngā tohu o nehe, o Kirikiriroa e noho nei au. I recognize the ancestral and spiritual landmarks of Kirikiriroa Hamilton where I now live. As part of my academic position at the University of Waikato, I was fortunate to collaborate with Indigenous students, colleagues, and community experts with Pacific and Māori backgrounds. I wish to acknowledge the support and guidance from my Indigenous collaborators.

Nicholas Vanderschantz

I was born in Aotearoa New Zealand and grew up in Whanganui on the ancestral lands of Ngāti Tupoho of the iwi Te Āti Haunui-a-Pāpārangi. I identify as Tangata Tiriti, a second generation New Zealander, with ancestral heritage to the Netherlands and the United Kingdom. I was fortunate to study tikanga, kaupapa, and te reo Māori growing up and I have actively worked to incorporate my learning in this area as a conscious part of my scholarship. I have been privileged to be invited to work with Māori, Cook Island, and Fijian students, colleagues, and communities in Aotearoa, to collaborate on investigations that support, develop, engage, and build capacity with cultural knowledge. I lend my skills as an academic whose work promotes human-centered design initiatives for information seeking and information use by communities small and wide.

S. 'Apo' Aporosa

Na yacaqu o Aporosa, sucu i Niusaladi, vasu ni koro i Naduri, Macuata, Fiji.
I was born in New Zealand, with a European father, although I identify as iTaukei (Indigenous Fijian), deferring to my mother's ancestral line and connection to the village of Naduri, Macuata, in Northern Fiji. My great great grandmother is Adi Maimalaga, the daughter of Tui Macuata Naerevono. I was schooled in New Zealand where I also worked as a policeman. This was followed by extended periods living and working in rural Fiji assisting with village and school development projects, primary health care and school teaching. The latter encouraged postgraduate study, resulting in a PhD focused on the importance of (Pacific) culture to academic achievement. I am currently a teaching and research fellow based at Te Huataki Waiora School of Health at the University of Waikato.

Danny Paruru

Ko Makeo tōku maunga – my mountain is Makeo
Ko Waiaua te awa – my river is Waiaua
Ko Omarumutu me Waiaua ōku marae – my traditional villages are named Omarumutu and Waiaua
Ko Ngāti Rua me Ngāti Patu ōku hapū – my traditional sub tribes are Ngāti Rua and Ngāti Patu
Ko Whakatōhea te iwi – my tribal name is Whakatōhea
Ko Mataatua me Nukutere ngā waka – my ancestors travelled to Aotearoa New Zealand upon the Mataatua and Nukutere traditional sailing boats.
Ko Daniel Paruru (Danny) tōku ingoa – my name is Daniel Paruru (Danny)

I live in the beautiful town of Ōpōtiki, which is located in the Eastern Bay of Plenty region of Aotearoa New Zealand. I am of Māori descent and have a strong affiliation to my tribe and community. I am the Iwi (tribal) Development Manager for the Whakatōhea Māori Trust Board, and I have a number of responsibilities particularly with regards to cultural and environmental development. I have a desire to participate fully in tribal activities that build resilience, build cultural awareness and to maintain our Whakatōhea way of being.

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