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Embedding indigenous science knowledge and values in higher education: Critical reflexive practice informed by successful Tongan science learners

Sonia Fonua

The University of Auckland
New Zealand

Abstract

As a non-indigenous science educator, I have embraced the idea of critical reflexive practice in order to be more responsive to the cultures and values of my Pasifika students and to become more inclusive of their indigenous knowledges. In this article I share three ways I have negotiated the incorporation of Pasifika values and knowledge into my teaching, based on my doctoral journey. This work is still in progress. My research uses both Grounded Theory and Pasifika (particularly Tongan) methodologies to explore successful Tongan students' experiences and views of their secondary schooling experience in Aotearoa New Zealand, Tonga and at university-level science studies level in New Zealand. Three examples show how data from my study has shaped my teaching practice. I contend that in order to improve the quality and equity of university science teaching, it makes sense to utilise the culture of students who are struggling in a system dominated by a different worldview.

Keywords

Science, indigenous science knowledge, Tonga, Pacific, critical reflexive practice, tertiary

Introduction

Formal educational outcomes of Pasifika learners have been of considerable concern since the late 1990s (Samu, 2013). The Education Review Office (ERO) has argued that, in terms of educational disparities, “students most at risk of not succeeding are Pacific” (Education Review Office, 2012, p. 4). Despite numerous targeted policies and initiatives, such as the Pasifika Education Plans (PEPs) developed by the Ministry of Education (MOE) (for example, Ministry of Education, 2015) to address disparities across all levels of the education system, recent evidence indicates that there has been very little shift in Pasifika academic results (Education Review Office, 2012; May, Flockton, & Kirkham, 2016). Although national educational policies (such as the PEPs and the Tertiary Education Strategy [TES]) direct institutions to be more inclusive of Pasifika cultures, languages and Pasifika communities, curricula, pedagogical approaches and organisational cultures continue to reflect predominantly ‘western’ values, knowledge and approaches. These often ignore the heterogeneity of



Pasifika peoples (Samu, Mara, & Siteine, 2008). In this paper, I outline how I have used my doctoral research to inform my critical reflexive practice (Cunliffe, 2004), in order to be more responsive to the cultures and values of my Pasifika (and other indigenous) students and more inclusive of their indigenous knowledges. I underpin this process by acknowledging that Pasifika students are constantly negotiating the often conflicting demands of formal western education and their own cultural understanding (Thaman, 2010). I share three examples that reflect this point: two relate to assessment and one to the delivery of course content. I draw on Thaman's (2003) argument that the inclusion of indigenous knowledge (IK) "usually results in mutually beneficial collaboration between indigenous and nonindigenous peoples, and improves their treatment of each other as equals" (p. 11). This creates a space for students to identify with, and develop within, their cultural understanding so that they are empowered to reclaim and (re)present their IK, culture and values. This makes subject content more relevant and relatable to them thus increasing their engagement with the course and their identity as indigenous learners.

Science achievement, participation and Pasifika students

Like many other OECD nations, science, as one of the STEM subjects, is considered vital for the national economic development of Aotearoa New Zealand (MOE & MBIE, 2014). Science education pathways through secondary and tertiary education are anticipated to enhance scientific literacy, so to better address the socio-scientific challenges of the future (Coll, Dahsah & Faikhamta, 2010). Yet international research indicates that fewer young people are studying science or pursuing science as a career, leading to an increase in scientific ignorance in the general populace (Osborne, Simon, & Collins, 2003). In Aotearoa New Zealand, Pasifika students are taking fewer science courses than other ethnicities (Turner, Irving, Li, & Yuan, 2010). Further, research evidence indicates that most Pasifika students who do take science are underachieving relative to their peers (Telford & May, 2010). Not engaging or not succeeding in science has major implications for Pasifika students in terms of employment opportunities, income and the ability to solve problems in their own communities (Samu et al., 2008). At the same time, it is indicated that by 2051 one in five children in Aotearoa New Zealand will be a Pacific child (Samu et al., 2008). This figure alone should provide further impetus for increasing our understanding of how to engage Pasifika students in science education.

At the tertiary level, although more Pasifika students are leaving school with University Entrance than in the past, enrolment rates are still lower than their non-Pasifika peers. There are proportionally more Pasifika in tertiary education than in previous decades — in 2014, 28.4% of 18-to-24-year-olds in tertiary qualifications at Level 4 or above were Pasifika (Education Counts, 2018). More Pasifika are being retained and are gaining tertiary qualifications. However, these improvements mask the fewer number of Pasifika students enrolled in the university system, an issue of concern that previous researchers have also raised (Benseman, Coxon, Anderson, & Anae, 2006; Middleton, 2008). This is a particular problem for science-related degree programmes. In 2016, 7.5% of domestic students studying Natural and Physical Sciences were Pasifika, while 7.4% of those studying Bachelor degrees in Natural and Physical Sciences were Pasifika (Education Counts, 2018). There have also been retention issues in the first year of study (Statistics New Zealand and the Ministry of Pacific Island Affairs, 2010). As Benseman et al. (2006) suggested over a decade ago, perhaps this is because the teaching and learning environments are hindering Pasifika student success.

However, when reflecting on this information, it is important to recognise that Pasifika peoples are not homogenous. Pasifika is defined as "a collective term used to refer to people of Pacific heritage or ancestry who have migrated or been born in Aotearoa New Zealand" (Ministry of Education, 2009, p. 3). Thus, there is considerable variation in ideologies and viewpoints amongst those categorised as Pasifika in pan-Pasifika education policies such as the PEPs. This approach masks the complexity involved in developing cultural understandings related to each different Pasifika group. It also occludes their "unique social structures, histories, values, perspectives and attitudes" (Samu et al., 2008, p. 146) as does the use of the term 'Pasifika' itself. Hence the motivation for my doctoral

study: to focus on a specific Pacific ethnicity so to understand more fully their particular experiences and needs.

Locating my study and myself

My doctoral research is designed to explore the engagement, retention, enjoyment and achievement of successful Tongan learners of science at university level. Tongan students are an increasing presence in both secondary and university education in Aotearoa New Zealand. For example, in 2016, Tongan students were the second largest Pasifika group in secondary schooling, while 17.9% of all Pasifika enrolments in a bachelor degree and 18.4% of Pasifika enrolments at university are Tongan (Education Counts, 2018). Would examination of the experiences of successful Tongan science learners enable identification of teaching and learning approaches and environments that foster achievement for all Tongan students?

I used individual semi-structured interviews to collect in-depth narrative accounts of the experiences of the 26 (16 female, ten male) Tongan science learners who volunteered to participate. Each interview lasted between 45 and 120 minutes. All interviews were conducted in English¹, yet responses were not exclusively in English. I am not a fluent Tongan speaker, but I encouraged participants to use Tongan words or phrases² if they wished. These I translated into English during transcription. As my research focus is Tongan science learners, I use the Tongan language where I can in my analysis and explanation. When I do I am preferencing the Tongan meaning of a word or phrase, especially for those words or phrases, such as *vā*, that may be shared across a number of Pacific languages, but may also have slightly different meanings within these groups. As part of the interview process, I spent time emphasising confidentiality and building connections, mutual trust and rapport. At the end of an interview, participant time and response was acknowledged with *me'a'ofa* (gifts). This action reflects Pasifika values of reciprocity, love and respect (Anae, Coxon, Mara, Wendt-Samu, & Finau, 2001). I was also mindful of the perceived hierarchy of relations between myself as teacher and the participants as students, even more so with gender differentials. This *vā* (relational space) between myself and the participants required careful, thoughtful nurturing in this research based relationship (Vaioloti, 2013/2014).

A combination of Grounded Theory (Creswell, 2012), Pasifika research methods (e.g., *Talanoa*) and Tongan specific approaches and frameworks (e.g., the *Kakala* Research Framework) informed my data analysis. In my research I also wanted to demonstrate how incorporating Tongan values, behaviours and concepts into my science curriculum and pedagogy can enhance student engagement and achievement for Tongan students (see also Kalavite, 2010). It is this aspect of my study, and how my students responded to incorporation of these factors, that I engage with in the second half of this article.

My position and teaching philosophy

As a Papālangi (person of European descent) ‘outsider’, I recognise my positionality impacts on my teaching and research and shapes the ‘critical reflexivity’ required to negotiate a clear space within the dichotomy of my ‘insider’/‘outsider’ status (Savvides, Al-Youssef, Colin, & Garrido, 2014). I have taught at university for almost 20 years, 15 of these teaching science on an indigenous-led foundation/bridging programme exclusively for Māori and Pasifika students. This has been challenging. Yet this position has also encouraged a critical self-reflection of my Papālangi privilege, and my engagement with culture and values and the power dynamics present when I teach Māori or

1. The participants were offered the option of English with the researcher or Tongan with a bilingual research assistant; all participants opted for English with the researcher.

2. Confidential translation services were available to interpret any narrative in the Tongan language.

Pasifika students as per the ideas of critical reflexive practice (Cunliffe, 2004). A critically self-reflective position is essential to take up when researching indigenous or minority populations (Anae, 2010; Merriam, Johnson-Bailey, Lee, Kee, Ntseane, & Muhamad, 2001). In my teaching and my research study, I also used Pō talanoa (conversations or discussions at night) with my Tongan husband and family and their networks. I used these times to check my thinking and to critique my Papālangi gaze on my teaching and what the participant said at the interview. Here I acknowledge the importance of fanongo (to listen or hear), as recognising what was not said or unsaid in talanoa is just as valuable for interpretation and analysis as what is said (Johansson Fua, 2009; Vaioleti, 2013/2014). Most importantly, my lived reality as the mother of Tongan children has informed and driven my aim to contribute to a new narrative about Tongan (and thus Pasifika) achievement and success.

Reflection on my own teaching

I wanted the outcome of my doctoral study to become ‘socially transformative educational research’ (Burnett, 2012), rather than a (valuable) source of information that did not necessarily trigger further action or sustained change. An excellent place to start within this vision was to respond to the reflections on how I, myself, was teaching Pasifika students I found in my data. The following examples demonstrate my critical reflexive position in the areas of science content delivery and assessment. I begin this section with the assumption that content and the style of delivery is more relevant and relatable to Tongan (and other indigenous) science learners, embraces their values and creates opportunities to increase their engagement with the course and their identity as indigenous science learners.

Example 1. Embedding Tongan values into course delivery

Since I began teaching the reproductive and endocrine systems I have been careful to acknowledge the content is *tapu* (sacred) for some students and can be affronting for cultural, religious or family reasons. For example, I begin class by recognising that some students in the lecture room may feel uncomfortable because of the mixed gender of the formal learning context, the use of anatomical images and/or because it triggers an aspect of their personal history. The intention is to create a respectful learning environment, outlining expectations of respect for others and demonstrating that I am aware that the topic is potentially a difficult one.

I used this approach prior to beginning my doctoral work, believing that I was demonstrating my cultural responsiveness and awareness, particularly of some Pasifika cultures. When my female participants mentioned learning about reproduction during their interviews initially, I felt quite proud of my approach, believing that it was good and appropriate. However, the following quote from one of my participants challenged this perspective:

Me: Has anyone ever acknowledged as a teacher that [reproduction] is awkward?

P: No

Me: Do you think they know?

P: No, I don't think so ... I know faka'apa'apa (mutual respect) is a very big concern for Tongan students who come here ... especially learning science in terms of biology ... we have that thing, of faka'apa'apa, of respect, between boys and girls and so there are some things that I am not meant to hear the boys say, and there are some things that the boys aren't meant to hear that I am saying especially with science on the topic of reproduction, yeah reproduction is a big one you can't really talk about sexual organs, or STDs, you can't talk about that stuff because in Tongan culture its embedded into us that that that stuff is meant to be separate, it's tapu ... you gotta be aware that there is a boy in the room so you can't talk about your own stuff so it kind

of restricts that especially in class [because] you can't really say, 'Oh boys, you need to go to that room and girls, you go to that room', and they will teach you the same lecture because that's just [not possible]... (Female; TE)

This story struck me because I had taught this participant in this class. They had experienced my lecture introduction and its intention to acknowledge and set people at ease. Clearly my statements had not been sufficient. This feedback was useful. While it demonstrated that any power dynamic that might have prevented my former students involved as participants in my doctoral research from saying negative things about my teaching was not the case, however well-intentioned, my efforts to address this confronting issue comfortably and safely were not explicit or appropriate enough.

In response, I adjusted my delivery of the reproductive and endocrine topics. I replaced the usual tutorial streams with gender-streamed classes that students can attend by self-identified gender. Students can choose which of their peers they are more comfortable discussing the content in front of: female-only, male-only or mixed gender. A few students (predominantly males) have questioned why it is not taught as it would be in Year 1 of the degree programmes (i.e., in a mixed gender class). My reasoning is that the Year 1 lecture would be mixed, but in Year 1 they would not have to participate in small group discussions for assessment (i.e., formative tests occur during the tutorial class time). In general, most female students now opt for a female-only session, regardless of ethnicity. This approach also empowers gender-fluid or trans-gender students to select where they feel most comfortable. We do not usually get enough interest in a male-only stream to run one, although it is always offered. I note here that some teachers might find gender separation in this instance problematic. I regard this as culturally responsive, with the understanding that pedagogical responsiveness can be far more nuanced than some educators may appreciate (Samu, 2006). An online anonymous survey of the current cohort indicated that having the opportunity to choose their tutorial cohort for this topic was helpful, culturally sensitive, valuable and, for the majority of students, considerate.

This example demonstrates how understanding what students are experiencing and thinking helps educators to adjust their delivery in culturally relevant and responsive ways. In this case, understanding how much a male presence impacted on their learning made me change my course. I wanted to demonstrate that it is possible to be responsive, and that values such as *faka'apa'apa* are respected in my course. One of the New Zealand Curriculum's visions is to ensure that it reflected "New Zealand's cultural diversity and values the histories and traditions of all of its people" (Ministry of Education, 2007, p. 8) and that students should learn about and express their own values. This statement suggests that Tongan students should be able to see their cultural values reflected in the curriculum content and that institutions and teachers should "use knowledge and ways of relating and teaching that acknowledge the culture of being Tongan for students in the New Zealand classroom" (Vaiotele, 2011, p. 30).

I have also begun considering which images I use, particularly in my lectures. Explicit images can also contribute to feelings of discomfort, as the following excerpt from this participant indicates:

P: Yeah, in [the lecture], it's awkward, it's very awkward between us ... especially like when you put up a picture of a penis and you're like am I meant to look at this? And it's really hard ... [I] think it's also that they don't give us a warning, you will just walk into class and bam! Ok, and all you can do is look down, and write, don't make eye contact with anyone, and I think it would be nice to acknowledge 'cos I know it's not just Tongan culture, its other cultures." (Female; TE)

I now annotate diagrams when I teach, often spending 10 to 15 minutes discussing and describing a single image. I do not want a student to feel uncomfortable with the image in front of them, so much so that they are unable to learn from it. As a result, I have reviewed all of my images to ensure they are not too explicit, or unnecessarily graphic.

Example 2. Embedding indigenous science knowledge (ISK) in assessment

During the analysis of participants' interview data, it quickly became apparent that the geographic location of their primary or early secondary school experiences was more tied into their level of success than participant nationality. Participants comprised two groups: 'Tongan Educated' (TE), indicating exposure to the Tongan education system; and 'Aotearoa Educated' (AE), indicating education in Aotearoa New Zealand with little or no experience of Tongan education. This example relates to the inclusion of ISK through assessment in the first semester course I teach and coordinate. The course focus is cell biology, human anatomy and physiology, not typically topics that reference ISK. Published examples of ISK being used in education in the Pacific are hard to find, outside of a few articles on sustainability, marine ecology and navigation. During the interview sessions it became clear that ISK had been largely absent from the formal science education of both groups. The AE participants in particular had very limited, if any, experience of ISK. The TE participants were more likely to have had some experience during their education in Tonga, although ISK ideas were not necessarily pitched at the level of 'formal science knowledge' within the classes. The following excerpt shows how participants describe (not) 'seeing their indigenous selves' as an aspect of their formal science education:

Me: So no part of your formal education have you had any references [to Tongan Science]?

P: Nope

Me: Informally?

P: [pause] At home? Yes, yes, not necessarily here in New Zealand though, when you go back to the islands, you get taught the Island way, 'cos there is that constant struggle of what you can and cannot do here in New Zealand, in terms of our traditional practices, [if] it clashes with the western views and western society, so there is a tension between being Tongan but with the, [pause] is it acting Palagi, with a Tongan brain or something like that? ... Like, you've got to blend in with the rest of society here in New Zealand, especially in science, you've got to blend in and learn all their terms, and learn everything and then go home but you can't put that in practice 'cos you got your own [traditional Tongan things] you have to follow. (Female; TE)

These comments were not surprising. When literature searching for my doctoral proposal, I was unable to find many examples of ISK being used in formal education in the Pacific. This resonated strongly with me. How could I enable my current students to express their ISK so that it was empowering, relevant and visible? As I focus on cell biology and anatomy and physiology, my courses originally had very little indigenous science content. In response to this finding, I developed an assessment designed to increase student exposure to ISK, both their own ISK and that of other indigenous peoples. I now ask students to describe indigenous healing practices they may have been exposed to, or currently use, that relates to one of the organ systems as per the modern western science knowledge (MWSK) view of the organisation of the human body. For example, traditional methods of wound healing are looked at alongside the integumentary system. This assessment has triggered many questions for the students, particularly how to reference unpublished ISK and the 'validity' of their examples. They are encouraged to discuss these concerns personally with me rather than over email, creating an opportunity to *tauhi e tau vā*, manage our personal relational space³, while unpacking what is ISK and whether their ISK example is 'real' knowledge.

³ This concept acknowledges the importance of maintaining personal relationships, with the understanding that maintaining a good relationship is not an easy thing to do and requires work.

For example, my students usually struggle with the idea that they do not need to reference their ISK other than by naming who they spoke to, or if it was a personal experience they could use first person narrative. Insisting on a published source echoes the struggle for many of my research participants to determine what is Tongan science knowledge and how it ranks in comparison to MWSK, as the following excerpt illustrates:

Me: Do you know anything about Tongan science? Like a body of knowledge [or] practices or approaches in Tongan culture that you would consider to be science?

P: Um [pause] not really I guess, 'cos I am so used to seeing it 'westernly', like I find it difficult to ... (Female, AE)

This assessment now provides an opportunity for students to reclaim and (re)present indigenous knowledge. They are also encouraged to consider the relevance and place of ISK in relation to the MWSK in the programme. I wanted to foster their appreciation and pride in their ISK, worldviews and experiences. Identities are formed by what students bring with them to the classroom but also what the classroom, school and educational contexts suggest to them about their academic ability, teacher expectations, and their academic potential (Carlone & Johnson, 2007; Jones, 1991; Samu, 2006). Arguably, being able to be proud of their culture, knowledge and values is an important way for indigenous students to develop a positive science learner identity. The following statements describes how being able to acknowledge their ISK in their formal science education was a positive experience for their identity:

P: Tongan Science? Would be navigation, that's what I know about Tongan Science, navigation, medicine, there is heaps of Tongan medicine.

Me: Do you ever hear about that stuff in your courses? Have you ever heard about it in any of your science courses?

P: Yeah, I heard about it in my humanities, in my Gen Ed [at uni], we talked about indigenous medicine or special healing, spiritual healing, cultural medicine, those kind of things, this is the first time I ever got to talk about it.

Me: How was it for you?

P: It was actually cool, like other people are more interested in my culture, and what I had to say and I never had, they come and asked me questions, like a lot of questions asked about what kind of medicines I took from my grandma.

Me: Other people in your class asked you?

P: Yeah, my tutor as well, they were interested. (Male, TE)

To evaluate whether this assessment is achieving its goal, current students completed an anonymous online survey asking them about the assignment. Overall, the feedback was positive with students describing it as fun and helpful, mana-enhancing and engaging. They also liked having the opportunity to engage with their culture and family knowledge and learn more about their ISK. They felt the assessment empowered them and made them feel proud. All ideas align with my aim to create space and opportunity for them to develop a positive science learner identity that embraces their indigeneity.

Example 3. Embedding indigenous values, knowledge and culture

Although commonalities exist across the Pacific region, there are also clear cultural differences between different Pasifika groups. It is important to acknowledge these differences, particularly as it has been argued that "an acknowledgement of their Tongan identity and the knowledge that their unique ways of learning and current knowing are respected" (Vaiolleti, 2011, p. 13) will improve Tongan student achievement at all levels of Aotearoa New Zealand's education system. The current

TES expects the tertiary sector to create learning opportunities for Pasifika students to be able to engage with their cultures, with the intention that this will assist with Pasifika retention, success and connection to their communities (MOE & MBIE, 2014). Previous research indicates that Tongan students' engagement increases in learning contexts that reposition Tongan ideas and practices as central to learning by using Tongan language, culture and values (Manu'atu, 2000, 2009). Further, using specific Tongan concepts, such as *mālie* and *māfana*, in the teaching of science, could transform the un-emotional atmosphere of the general science classroom to one that energises Tongan students to learn (Manu'atu, 2000). *Mālie* can be understood as something that is entertaining, a form of positive feedback, or recognition of skill and *māfana* as a process of becoming impassioned or emotionally moved. Manu'atu (2000) argued that these two concepts are transformative, allowing for the possible to occur out of what has been impossible.

Including Tongan scientific knowledge in the curriculum would also increase the relevance to Tongan students. Key elements of Tongan culture can be used to transform the learning environment. These include recognising the importance of group work in Tongan culture and making it an effective teaching and learning method to emphasise in the classroom ('Otunuku, 2010). These suggestions allow teaching and learning to occur in ways that allows Tongan (and other indigenous) students to fit in both worlds. Students can then address the current dichotomy of their (western) educational system and their own culture, while acknowledging indigenous cultural practice helps address the learning gap that may exist.

As a result of listening to my PhD participants, I have designed an assessment for my students to create their own ways of telling, teaching and explaining the course content. In small groups (usually three, maximum four) they create a dynamic model in any medium (i.e., animation, game, dance, song) to teach a course learning objectives, using their cohort as the target audience. Each group has three weeks to produce a short video (3-4 minutes in length) of their model. These are uploaded to their online course system and peer evaluated to ensure the teaching medium is deemed appropriate and useful. This process encourages them to watch the videos, which are then available as study tools for their final course exam (any inaccuracies are amended as part of the marking process). Each student must also write an explanation of the objective they are portraying and why the chosen style of delivery was the most appropriate. These assessments showcase student culture and encourages them to actively learn an important concept so they can teach it in a creative way. They are encouraged, but not expected, to use indigenous knowledge in the interpretation or delivery of a teaching tool. However, they are expected to consider their indigenous and youth perspectives. It is hoped they will foster an appreciation and pride of their indigenous knowledge, languages, worldviews, teachings and experiences through their own indigenous science learner lens.

Anonymous student feedback from the current cohort shows that they find the assessment helpful, engaging and fun. They also found them time-consuming, primarily the creation and production aspects, but also the need to truly understand the content to present it well. The access logs indicate that the videos have been well used for learning and revision before tests, labs and exams. Overall, the current students enjoyed group work because it helped deepen their understanding, often sharing useful analogies. The use of humour in these models is also a way that *māfana* is embedded into the course. Most of the videos appeal to the student audience, using humour and culturally relevant stories that speak to the students and their realities. For example, using the cultural differences around dating for Pasifika and *Papālangi* girls as an analogy for the different cell signalling pathways. Although *māfana* is a Tongan concept, it is one that translates well to others, and as Manu'atu (2000) suggests, it is a feature that combats the seriousness of the content. The best models are those that demonstrate an understanding of student contexts, an understanding only they can have. Instead of expecting students to navigate the learning gap so they can achieve, I am encouraging them to help me navigate their 'learning gaps' in my course. This teaches me to transform my learning approach to better engage Tongan and other Pasifika students so that they can enjoy and be successful as science learners.

Weaving the examples together

I believe these examples highlight how simple changes can create teaching and learning contexts where indigenous or minority students, such as Tongan science learners, can safely express their language, culture and values. These changes enable the repositioning of Tongan ideas and practices as central to learning (Manu'atu, 2000, 2009) and showcase how concepts such as *māfana* can energise science education (Manu'atu, 2000). The examples also highlight how much can be achieved when educators recognise the importance of *tauhi e tau vā*, managing the personal relational space between themselves and their students, in a manner that suits their student audience, rather than themselves or the institution.

In common with other indigenous groups, traditional Tongan education emphasises the importance of having positive relationships. This includes a strong emphasis on the communal rather than the individual (Kalavite, 2010). These relationships are maintained by specific Tongan values, including *fatongia* (duty/obligation) and *faka'apa'apa* (mutual respect). These core values are seen to be incongruent with those imposed by the dominant western education paradigm (Taufe'ulugaki, 2003) which emphasises abstract and decontextualized learning that is often not related to indigenous students' cultural realities (Thaman, 2010). Rather than seeing Tongan values and behaviours as a disadvantage, it is essential for educators to be aware of their importance and for students to determine how to balance their cultural and academic obligations to benefit from their Tongan culture and ensure their engagement and academic achievement (Kalavite, 2010). The above examples highlight how the process of educators recognising and using values, such as *faka'apa'apa* to *tauhi e tau vā*, enables their Tongan (and Pasifika) students to create a learning environment that allows them to learn, enjoy and succeed *as themselves* in science.

Conclusion

Teachers of Pasifika students should understand that their students are constantly negotiating the demands of their formal western education and their own culture (Thaman, 2010). In particular it is important to recognise how these two value systems can be in conflict and create a 'learning gap' between the learner's culture and the learning event (Little, 1990). Although not a new concept or critique, very little non-western knowledge is acknowledged in Aotearoa New Zealand's secondary schools or universities despite attempts by education policies to be inclusive of Pasifika cultures. Instead, most secondary and university formal curriculum and pedagogy continues to reflect western values and knowledge sources. This is despite evidence that suggests including indigenous knowledge, culture and values enrich education, counters the dominance of western content and pedagogy in the education of Pasifika, and creates inclusive learning environments (Thaman, 2003).

My research and the musings on my critical reflexive practice it created, adds to the limited research on the teaching and learning of university science in Aotearoa New Zealand, particularly for Tongan students. In order to improve the quality and equity of university science teaching, it makes sense to utilise the culture of the students who are struggling in a system dominated by another worldview. My examples echo previous research findings that addressing staff knowledge of Pacific cultures, the type of teaching strategies used (Education Review Office, 2010), teaching and learning relationships and institutional commitment contribute to Pasifika student success (Chu, Abella, & Paurini, 2013). However, my examples also emphasise the benefits of embedding indigenous knowledge and values and the potential to make institutional change for the betterment of student academic achievement. If there are issues of engagement, achievement and success for Tongan science learners in Aotearoa New Zealand, my own critical reflexive practice shows that understanding and incorporating various Tongan cultural practices and approaches to education and learning can provides tangible solutions to these problems.

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