

## Indigenous Teacher Education: When Cultural Enquiry Meets Statistical Enquiry

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For Indigenous students in minority education contexts, it is important that teachers have strategies to combine both cultural knowledge and mathematical knowledge in appropriate ways. This paper presents the results from analysing preservice teachers' statistical enquiry assignment linked to a cultural context, in a Māori-medium teacher education programme. The results indicate that there are many tensions in trying to honour both the learning of cultural and statistical understandings. The findings provide insights to teacher educators about what may be needed to reduce some of these tensions and the implications for teachers working in Māori-medium schools.

### Introduction

How teacher education prepares Indigenous teachers to teach in Indigenous schools is an under-researched area in mathematics education research. Consequently, in this paper, we investigate how Indigenous preservice students in a Māori-medium teacher education programme responded to an assignment, in which they were asked to combine cultural understandings with statistical enquiry. In setting up the project, it was anticipated that cultural understandings could be gained with a range of tribal and national literature and from elders' oral sources. The statistical enquiry used the statistical enquiry model.

Initial teacher institutes (ITE) have existed since 1862 in Aotearoa/NZ (Openshaw & Ball, 2006), but were English-medium only for over 110 years, reflecting assimilationist policies of the European colonisers. The impact of research in the 1970s (i.e., Benton, 1979) that showed te reo Māori, the Indigenous language of the Māori people, was in a precarious state and the subsequent demands by communities and activists to revitalize the language, saw a rapid growth in students learning the language (Walker, 1984). However, it was not until 1974 that there was a response to the lack of te reo Māori teachers by providers of ITE through programmes, such as Te Atakura, which fast-tracked native speakers into a teaching qualification (Shaw, 2006). However, these programmes focused on meeting the demand for language teachers of te reo Māori for secondary schools and not the chronic shortage of teachers of Māori-medium schooling, apparent in the 1980s.

By the early 1990s, various ITEs, under pressure from the schooling sector, responded by developing bilingual-type programmes. While based on good intentions, in these programmes Māori culture was acknowledged and given some emphasis, but the programs did not develop the te reo Māori proficiency of the teachers needed to teach in Māori-medium schools (Stewart, Trinick, & Dale, 2016). However, by 2008, 12 programs defined themselves as Māori-medium (Murphy et al., 2008), including the programme in this study. The programme is a three-year Bachelor of Education (Teaching) programme, located in the Faculty of Education at the University of Auckland. It is unique in Aotearoa/NZ, as it is the only degree in the University delivered in the medium of te reo Māori. The programme aims to produce teachers who can actively engage in te Ao Māori (the Māori world) in terms of language, knowledge, commitment, pedagogy, understanding of tikanga (cultural customs), and how tikanga plays out in a range of contexts. The programme is comprised of courses in each curriculum area such as mathematics

(pāngarau) and professional knowledge. It also includes a school placement each year in Māori-medium kura (schools).

From its inception, the programme has sought to address the complex challenges of language revitalization (Dale, McCaffery, & McMurchy-Pilkington, 1997) and the need to develop new linguistic resources for discussing and disseminating conceptual material at high levels of abstraction (Trinick, 2015). Where the programme has not done so well is the revitalisation of cultural knowledge. This programme, like many others in ITE, have focused on revitalising and elaborating the language to enable subjects, such as mathematics, to be taught at the tertiary level (Trinick, Meaney, & Fairhall, 2014). This is also reflected in the schooling sector where graduates of this programme and others have struggled to revive mathematical ideas or to locate mathematics in contexts that can be considered authentically Māori (see Trinick et al., 2016).

In order for Māori-medium learners to achieve success and Māori-medium schooling to survive and flourish as an indispensable component of te reo Māori revitalization, a continued supply of teachers with the necessary competencies, skills and disposition is required (Hohepa, Hawera, Tamatea, & Heaton 2014). While there is ongoing debate about what this range of skills and dispositions ought to be, we argue that teachers require two skills—the ability to discuss and disseminate conceptual material at high levels of abstraction in te reo Māori and an understanding of relevant mātauranga Māori (Māori knowledge). As Murphy, McKinley, and Bright (2008) note, Māori teachers who struggle to put “language into a cultural context for students” will contribute to “students learning language without any of the richness and experience associated with culture” (p. 36). Although we highlight only two dimensions of being an effective teacher, this definition has significant implications for the teaching and learning of school subjects and for Māori language and knowledge revitalization. In this paper, we describe the results of a project with preservice teachers that set out to merge Western mathematical ideas, from the statistics investigation cycle, with questions about the early Māori migratory voyages.

### Early Canoe Migrations

Almost all the students in this BEd (Teach) programme are descendants of families who were involved in the rapid and extensive urban migration after the Second World War, where Māori families shifted from socially isolated Māori-speaking communities into English-language-dominated urban areas, and into English-language-only schooling systems and workplaces (Spolsky, 2005). Consequently, many of the younger generation, including students in this programme, struggle to reconnect to this knowledge. Early canoe migrations could provide a useful context for developing relevant cultural knowledge.

The various canoe migrations are important to the identity of Māori in Aotearoa/NZ both in historical and contemporary times (Orbell, 1975). The canoe (waka in Māori) traditions describe the arrival of Māori ancestors from a place, most often called Hawaiki. The exact location of this Hawaiki has been lost in the mist of time and has been the cause of much speculation. With the advent of technology such as DNA mapping, it is now well established that most of the Māori migratory canoes came from different points in East Polynesia, more specifically, Raiatea, Tahaa, Porapora, Tahiti and some of the islands of the Cook Group (Underhill, et al. 2001) (see Figure 1). The migration stories refer to the construction of canoes, conflicts before departure, voyaging at sea, landing, inland and coastal exploration, and the establishment of settlements in new regions (Orbell, 1975). Genealogical links (whakapapa) back to the crew of founding canoes have established the origins of tribes and define relationships with other tribes. For example, several tribes trace

their origin to the Tainui canoe, while others, such as Te Arawa, take their name from their ancestral canoe. When identifying themselves on a marae (meeting house) outside their tribal area, people refer first and foremost to their waka. Alongside tribal dialects, a person's waka is a significant identity marker for Māori. Canoe traditions explain origins and also express authority and identity, and define tribal boundaries and relationships. They “merge poetry and politics, history and myth, fact and legend” (Taonui, 2006).



Figure 1. Canoe journey in the Pacific (from Royal, n.d.).

While the precise date of the canoe migrations is a matter of debate, there is a large amount of material, both traditional (oral stories and artefacts) and contemporary (modern voyages using traditional methods, DNA testing) that provide information about these earlier voyages. However, as can be expected considering the antiquity, there are many unanswered questions surrounding aspects of the voyages, for example, how long did it take the waka to get to Aotearoa? Questions such as these have implications for the validity and reliability of traditional wayfinding knowledge. This is one of the questions, the preservice teachers in this research were asked to evaluate, drawing on the various data sources that were available to them using the statistics enquiry cycle.

### The Statistics Enquiry Cycle

The separate and distinct nature of statistics is well-established in New Zealand and recognised as having different ways of thinking and solving problems from mathematics. Moore (1998) argued that, “Statistical thinking is a general, fundamental, and independent mode of reasoning about data, variation, and chance” (p. 1254). With technology to do the “number crunching”, it is more valuable to focus on the statistical process.

With the publication of the English and Māori-medium versions of the New Zealand curriculum in 2007 and 2008 respectively (Ministry of Education, 2006; Te Tāhuhu o te Mātauranga, 2008), the subject “mathematics” became “mathematics and statistics”, with the difference being connected to two related, but different, ways of thinking.

Mathematics is the exploration and use of patterns and relationships in quantities, space, and time. Statistics is the exploration and use of patterns and relationships in data. These two disciplines are

related, but they use different ways of thinking and solving problems. Both equip students with effective means for investigating, interpreting, explaining, and making sense of the world in which they live. (Ministry of Education, 2006, p. 26)

Statistical investigations involve information gathering to seek meaning from and to learn more about phenomena as well as to inform decisions and actions. Wild and Pfannkuch (1999) argue that the contextual nature of the statistics problem is an essential element and how models are linked to this context is where statistical thinking occurs. Thus, one of the goals of the preservice teachers' task was to learn more about a real-world situation, canoe migrations. While based in antiquity, canoe migrations and the resurrection of wayfinding skills is a contemporary topic of interest (Trinick et al., 2016).

In the Aotearoa/NZ schooling system and curriculum, including Māori-medium, it is recommended that statistical investigations are conducted using an enquiry cycle. The cycle defines the way one acts and what one thinks about during the course of a statistical investigation (Wild & Pfannkuch, 1999). The cycle as proposed by Wild and Pfannkuch (1999) consists of five stages: Problem, Plan, Data, Analysis, and Conclusion.

- The **problem** section is about understanding and defining a problem and formulating a statistical question.
- The **planning stage** is about how the data will be gathered and measured, and the design of the study. This also includes the sources of data: a primary source, i.e., data collected by students, or secondary sources, i.e., data already collected by someone else.
- The **data** stage is about how the data is managed and organised and cleaned and
- The **analysis** stage is about sorting the data, constructing appropriate data displays and numerical summaries, looking for patterns and reasoning with the data.
- The final stage of the cycle involves interpreting, generating **conclusions**, new ideas and communicating findings.

One of the advantages of a cyclic approach according to Wild and Pfannkuch (1999) is that this model provides more structure in the learning process, particularly for those who are generalist teachers, as opposed to specialist statistics teachers.

## Data Collection and Analysis

Data were collected from 18 preservice teachers in the final (3rd) year of a Māori-medium initial teacher education programme. The preservice teachers were required to complete two assignments, one was a statistical investigation on their ancestral waka, the other was to develop a unit of work showing how they might teach the statistics enquiry cycle to students. The data that were analysed were the written assignments completed for the statistical investigation. Permission was asked of the students to use the assignments for the data analysis, in the semester following their completion of the course.

The statistical investigation included the following guiding questions:

- Name your ancestral waka, and where do you think it came from and why?
- How many people were on board?
- What do you think was the gender, age group mix?
- What sort of foods did they bring?
- How long did they take to get to Aotearoa?
- If all of the above is not available you will need to predict the answers using the variables (information) that is known.

Wild and Pfannkuch (1999) argue that thinking about the variables involved in a statistical investigation is an important consideration particularly when linking the context to the statistics model used. However, it is known that inferential thinking is difficult for preservice teachers to understand (Leavy, 2010). Statistical thinking also occurs when statistical processes within the cycle are questioned; for example, what type of data is needed to answer the questions posed? Which graph is best for this type of data? What are the statistics, graph or table inferring about the waka data? What are the statistics, graph or table inferring about the waka population?

## Findings and Discussion

When the statistical assignments were original graded, it was noted that the preservice teachers faced issues that had been unexpected when the project had been set up. Thus, it was decided to investigate these issues further. To do this, the issues were faced at different points in the statistical enquiry model were identified and described below.

### *Understanding the Problem*

The first challenge for the students was coming to terms with investigating a topic which was traditionally considered a “taonga tuku iho”—a treasure handed down from the ancestors, thus not generally considered open to question and enquiry. This is an issue which has sometimes impinged upon the revitalisation of mātauranga Māori (Māori knowledge) in schooling and this issue was connected to choices about relevant data that the students drew on to answer the questions.

### *The Planning Stage*

The choice of where to gain data from seemed to be affected by how much the preservice teachers felt that the knowledge was open to questioning. As a consequence, some students drew on only one source of data, such as an elderly relative, while others drew on a range of both written and oral sources. The source and authenticity of the data created a real tension throughout the process. As noted, the migration stories contain both fact (they did occur) and legend (the prowess of the captain of the canoe) (Orbell, 1975).

### *The Data Stage*

It was difficult for the preservice teachers to completely discount evidence from elders when managing and organising the data. However, one of the unintended consequences of the students’ investigations was that they also used the investigation to survey the knowledge of their own extended families including their relatives by marriage from other tribal areas. A number sent out an electronic survey via Facebook and/or used Survey Monkey. The answers tended to vary wildly from relative to relative. However, some students did note it was because mātauranga Māori (Māori knowledge) is not standardised and it was important is to acknowledge the difference. For example, one student noted:

Each tribe or hapu have their own pūrakau (stories), hitori (history) and kōrero (talk) pertaining to Mahuhu-ki-te-rangi. Who am I to question it. I can’t tell the people of Te Roroa that Rongomai is the captain because he is most likely according to the data, therefore their history is koretake (useless).

Thus, the assignment also turned into an assessment of how much their relatives knew. It may be that school statistical projects which often survey family members (see for

example, Makar & Rubin, 2009) influenced the preservice teachers' perceptions that such a survey was useful for gaining relevant knowledge. Nevertheless, several were able to navigate between a range evidence by deferring to a reasonably logical option:

According to the data I collected, the journey ranged between 5 days to 76 days, so I chose somewhere in the middle.

### *The Analysis Stage*

In the analysis stage, the preservice teachers responded to the questions, some of which had a large degree of uncertainty, for example, the number of people on board the canoe. While there are formal statistical methods to reduce uncertainty, one of the goals of this assessment was to encourage students to draw on mathematical ideas, such as measurement estimation to support the interpretation of the varied data.

While there were one to two outliers, where South America was identified as a possible source of origin for the waka, most preservice teachers identified East Polynesia as the place of origin of their ancestral canoe. However, the exact island in East Polynesia differed even when the preservice teachers identified with the same canoe.

Through extensive research the closest I have come to identifying the island of Hawaiki which our ancestors claim to have come from is the modern-day island of Tahiti.... Looking back on our history, these are also similar traits to Māori people. Tupaia was on board Captain Cook's ship when it arrived in Aotearoa and even though he was from a completely different island far away, Captain Cook's records showed that he [Tupaia] had great success communicating with Māori.

The next question, which asked, "How many people on board?" required a synthesis of the various variables. To calculate the estimated length of the journey requires rational reckoning and logic to determine position, distance, size of canoe and so on. While this can never be answered exactly it can be estimated by the time it had taken modern replicas of traditional Māori sailing canoes (Taonui, 2005), which have taken between 24 and 18 days to sail to and from Rarotonga (Taonui, 2005) Most of the students used this information, particularly the accounts of the voyage Te Aurere throughout the 1990s up to recent times

I estimated the time for the voyage of my ancestral waka at 36.7 days from Rai'atea to Aotearoa. This was based on contemporary waka voyagers by Hekenukumai Busby which took him 30 days to travel 3233.73 km from Aotearoa to Rarotonga, traveling around 146.98 km per day

These results differed to the information gained from whānau (family) informants who predicated the voyages as being very quick (seven days) or very long (four months). One preservice teacher working it out using distance and time calculations, stated:

In relation to the question on the estimated number of people on board and the gender mix, estimates varied from a low of 15 to a high of 250. There was some doubts expressed about this later number, I decided there was between 20 to 30 because it was the most common estimate. This was based on the length of the voyage, the amount of food needed to be carried and so on.

### *Conclusion Stage*

As noted in the previous section, conclusions were drawn from the analysis stage, but the reflections needed to query the responses' appropriateness were not always apparent. In regard to the gender mix, while most preservice teachers agreed that the people would comprise a gender mix, they almost always estimated more men than women.

It was very clear to see that the majority (21) participants of this survey believed that there were more men on board than women, and 2 participants believed there were equal number of men and women aboard the ..... waka for the following reasons:

Men were stronger at paddling

Women were there to help look after men who were paddling

Men needed women to reproduce offspring

It is also difficult to know just how much preservice teachers' knowledge of ancient canoe migration is influenced by their observations of major cultural events. Traditional ocean-going waka used for settlement were sailed, rather than paddled. Paddling is the norm for the various ceremonial waka that preservice teachers see on special cultural occasions. However, what is important for understanding the tension between cultural and statistical knowledge is that the preservice teachers did not always see the need to query what their relatives told them with other data.

## Conclusion

Teaching subjects like mathematics in Māori is a relatively recent phenomenon and the issue of where Māori knowledge fits is an ongoing debate. The preservice teachers in this study accessed the literary information in the public domain. However, some knowledge still resides in the private, localised domain. How to evaluate the value of these two forms of knowledge is a significant tension. Western knowledge gains prestige by being in the public domain and contested, while Indigenous knowledge gains prestige in other ways.

One reason for choosing waka is that the knowledge about the canoe voyages can be considered something to which all the preservice teachers could relate, but relevant background knowledge was not always known to the preservice teachers, due to the loss of connection through urbanisation. In future, preservice teachers will be expected to create their own investigative questions about their waka of origin as the ability to construct questions as part of the investigation cycle is important (Wild & Pfannkuch, 1999).

Most of the students acknowledged the variation in the data between published and family knowledge and knowledge held by the tribe itself. None of these sources should be considered as having more validity, but only some of the preservice teachers were able to mediate between the variation in the data sources. For example, the assertion by some of the informants of particular waka that no women were on board was rationalised on the grounds that perhaps that the ancestral canoe was exploring new lands rather than seeking re-settlement, which would have had a different composition in those on board. However, most preservice teachers were sensitive to their elder's cultural knowledge. This is partly because Māori have collective ownership of the knowledge—hence why relatives are considered appropriate informants. Some discussion is needed in the future about how to respectfully integrate different knowledge sources.

In statistical enquiry, scepticism is considered as a disposition of statistical thinkers, but it is not necessarily so within the Māori family in regard to cultural knowledge. Knowledge is certainly contested between tribes and vigorously so, when it comes to resources. The challenge for the mathematics teacher, both in teacher education and in schools, is to utilise understandings about contesting knowledge from these discussions about resources in other situations where knowledge sources provide different information.

Upon reflection, we considered that there needed to be more discussion on “What does enquiry mean?” at the start of the project. We now considered that it was important to raise the question of how can the cultural knowledge be respected while simultaneously questioning it. This is because scepticism is identified as a disposition of statistical thinkers (Wild & Pfannkuch, 1999). One of the strategies would be to examine more culturally sensitive questions including discussing with students such questions as when does cultural

understandings have precedence over statistical knowledge? It is also important to guide students to develop their own questions. Chance (2002) and others argue instruction should encourage students to view the statistical process in its entirety.

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