Chapter 8
Using the Mathematics Register Outside the Classroom

Te reo Māori was the language of communication when the first European settlers arrived in Aotearoa/New Zealand. Since then it has been used continuously as a first language in some parts of New Zealand. More recently, it has become the second language of many others. This increase in second-language speakers has come about as a result of the revitalisation movement. An aim of this movement in the latter part of the twentieth century was to have *te reo Māori* serve as many functions as possible, and not be relegated to talking only about traditional matters. However, this remains a challenge with much uncertainty about how to ensure that the best opportunities are made available for *te reo Māori* to be used in a range of domains. An ongoing tension is the need to increase opportunities for the language to be used, whilst at the same time ensuring the integrity of the language. Given that the mathematics register can be used in solving real-life problems that need a mathematical solution, the focus for this chapter is how the specialised terminology of the mathematics register is being used in the wider community. We also look at how ex–Te Koutu students transition from school to work and further study and how they use and learn more mathematics.

Before the 1980s, many prominent Māori advocated the use of English, especially by the rapidly growing, post-war, urban population. English was seen as the language of social improvement from the beginning of the twentieth century, and many Māori stopped using *te reo Māori*, except on the *marae* or in religious services (Te Puni Kōkiri, 2004). Consequently, *te reo Māori* was used for a limited number of functions. Since the 1980s, with the revitalisation of the language, there have been hopes that once again *te reo Māori* would be used to fulfil a similar range of functions to that of English. However, for these hopes to be realised a number of factors must come into play. The first and foremost of these is having a vibrant community of speakers. Figure 8.1 shows that in 2006 the number of speakers who felt that they spoke *te reo Māori* very well, or well, had since 2001 increased in the four youngest age groups.

Given that this age group would mostly be in the workforce, with some in the youngest group coming from Māori-immersion schooling, there is potential for these speakers to use the mathematics register in *te reo Māori* in their everyday

T. Meaney et al., *Collaborating to Meet Language Challenges in Indigenous Mathematics Classrooms*, Mathematics Education Library 52,
DOI 10.1007/978-94-007-1994-1_8,

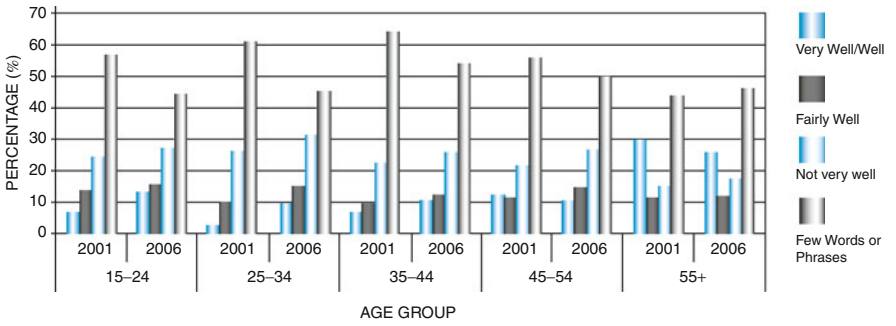

Fig. 8.1 Māori-language-speaking proficiency by age (from Te Puni Kōkiri, 2007a, 2007b, p. 5)

Table 8.1 Percentage of Māori adults who speak Māori outside the home, and whom they speak to

Person spoken to	All Māori/Māori equally	Mostly Māori with English	Some Māori no Māori (i.e. less than/50 percent Māori)
Visiting relatives/friends	9	10	82
Working	7	7	85
Sport	3	7	90
Helping out at school	20	12	68
Shopping	1	4	94
Religious activities	21	11	68
Club or interest group	20	16	63
Hui	23	19	58
Marae activities	32	17	51
Socialising	3	8	89

From Statistics New Zealand (2002)

conversations. Yet in 2001, information gathered from nearly 5000 Māori respondents showed that only 14 percent used *te reo Māori* at least 50 percent of the time (Statistics New Zealand, 2002). In social situations, where the mathematics register might also be used, such as with sport or shopping, the use of *te reo Māori* was even less. This information is shown in Table 8.1. By 2006, there were more Māori using *te reo Māori* "some" or "most of the time" in all domains. However:

> In … 2006 fewer people spoke Māori for half or more of the time while shopping (7%), at sports (9%), while socialising (10%), at work (15%), and while visiting relatives, friends or neighbours (20%). This information suggests that the most use of Māori language in community settings is in cultural practices and formal occasions. More instances of Māori language use outside of these settings is needed until normalisation of the language is achieved. (Te Puni Kōkiri, 2008a, p. 32)

An increase in the use of *te reo Māori* is not simply a matter of more people being proficient. People need to see the possibilities for using the language and then want to take advantage of them. In relation to this issue, the attitudes of non-Indigenous people to the use of Indigenous languages has been a concern (May, 2000). In a 2006 survey of attitudes to *te reo Māori*, 80 percent of non-Māori respondents and almost a hundred percent of Māori respondents thought that it was a good thing for Māori to speak Māori in public (Te Puni Kōkiri, 2006). To temper this positive response, Boyce (2005) found, in regard to attitudes to *te reo Māori*, that "the wider community will express more positive responses to generic questions, but will indicate more negativity as questions become more specific" (p. 94). In a report by Te Puni Kōkiri (2001) on students' learning *te reo Māori* as a second language in high school, one of the reasons given by Māori students for not learning it was that there was "little real-life application for *te reo*" (p. 8). In the same survey, parents suggested that having the language might contribute to their children gaining jobs in tourism or with some government departments. However, a report on Māori tourism in Rotorua commented that the use of *te reo Māori* would not necessarily have positive outcomes for the language.

> Participants generally felt that tourism could be used to promote Te Reo in a far more positive light. One of the other impacts on Te Reo was the tendency to use transliterations because the depth of reo Māori "proper" would require more explanation and may be too complex for tourists to comprehend.
>
> Thus, tourism is seen as a mixed blessing for Te Reo, with positive outcomes requiring a more concerted effort overall. (Tahana, Grant, Simmons, & Fairweather, 2000, p. 53)

So the likelihood of *te reo Māori* being used in workplaces depends on a number of aspects aligning, even if there is a sufficient number of language speakers. For instance, the communication partners need to be at a similar level of proficiency if the language is to be used in more than a superficial way and in a way that is not detrimental to the language. Using the mathematics register to solve problems requires a higher level of proficiency than would be necessary to have a discussion about the weather, which also requires the use of aspects of the mathematics register.

Although there have been many surveys about Māori people's use of *te reo Māori,* there has been little research about whether the new registers created for schools have transferred into the wider community and incorporated into everyday speech. Of the small amount which has been done, there is no research that investigated the features of the mathematics register that appear in *te reo Māori* use in the wider community.

In order to determine where the mathematics register was used, it was necessary to look at situations in the wider community where aspects of the register were likely to appear. One of the domains where *te reo Māori* is spoken outside the classroom is the media, particularly radio and television, and it also has an increasing presence in e-media mostly driven by young Māori (Te Puni Kōkiri, 2010). Currently, there is minimal language print media in the medium of Māori outside a few localised newspapers. In the next section, we briefly describe the history of Māori broadcasting before presenting the results from a research project that monitored the different *te reo Māori* mathematical terms used on television over a two-week period in 2009.

Te Reo Māori and Broadcasting

Internationally and nationally it is recognised that the media has a role to play in the revitalisation of an Indigenous language (Hinton & Hale, 2001). Broadcasting in *te reo Māori* in Aotearoa/New Zealand has a long and complex history, with much discussion over whether the funds expended on it contribute significantly to the revitalisation.

Up until recently, there was very little broadcasting in *te reo Māori*. It was not until the Second World War that radio airtime was dedicated to discussing in *te reo Māori* the exploits of the NZ Māori (28th) Battalion. *Kaumātua* or Māori elders had petitioned parliamentarians to gain this time slot (Te Ua, n.d.). From then on, a 15 min news bulletin was broadcast once a week, written and read by Wiremu Parker. Originally all material was censored by the Prime Minister's Office. It is reported that Wiremu Parker did not use English words and by implication transliterations in his broadcasts (Te Ua, n.d.). However, this was not the norm either in later *te reo Māori* broadcasts, or in the earlier *te reo Māori* newspapers. These newspapers had flourished in the early part of the twentieth century, but most had ceased publication in the 1930s.

In the 1930s and 1940s when *te reo Māori* was still the first language of many Māori, the main employing industry, agriculture, would have been discussed extensively in *te reo Māori*. It is quite likely that discussions of selling and buying produce through markets would have required the use of the mathematics register. However, as mentioned in Chapter 2, this was in the era when transliterations were prevalent in the language, and the mathematics register probably did not develop much from the level it had reached in the mid-1800s.

The use of technology of any kind in recording *te reo Māori* is likely to have implications for the language. Kamira (2003) warned that technology, even the simplest form such as pencil and paper, has had a significant impact on Indigenous knowledge. She felt that Pākeha written accounts of Māori in the early 1800 transformed knowledge by first separating it from spirituality and then by "a systematic process by which Māori knowledge was discarded, modified or validated to suit an English international strategy for colonization" (p. 466). It is possible that newspapers and early broadcasting contributed to the proliferation of transliterations in the mathematics register, thus contributing to the distortion of Māori knowledge. In the first half of the twentieth century, when *te reo Māori* was still spoken by the majority of Māori, language change occurred slowly and Kamira's concerns perhaps are not relevant when Māori themselves chose to use their language in the media. Yet the impact of new technologies on *te reo Māori* cannot be understated, as is illustrated in the way that English has had to grapple with the new dialect of text language.

While there was more regular use of *te reo Māori* on the radio after the war (Te Ua, n.d.) and intermittent use on the new medium of television (Middleton, 2010), it was not until the 1980s that significant progress was made towards a Māori broadcasting policy. Along with the recognition by the Waitangi Tribunal of *te reo Māori* as a treasure came the requirement for joint responsibility to maintain it by the government and Māori. The role of broadcasting, much of which, at that time,

was owned by the government, was criticised for its contribution to the decline of the language (Hollings, 2005). This resulted in the government being forced to support a number of legislative and policy remedies including funding Māori language radio and television. A large number of *iwi* (tribes) set up their own local radio stations as a direct consequence of being given radio frequencies to transmit on. A pilot television station was also operated for a twelve-month period between 1996 and 1997 in Auckland (Te Puni Kōkiri, 2008b). However, Middleton (2010) stated:

> The Government's early efforts to respond – such as a Māori-Crown bid for a third channel and the pilot for a Māori channel – were isolated and under-funded measures rather than the expression of a coherent, long-term strategy underpinned by solid foundations. (p. 167)

In considering how to respond to the Waitangi Tribunal's findings, the role of mainstream television and radio came under the spotlight (Hollings, 2005). By having *te reo Māori* as a language for mainstream broadcasting, it was believed that its profile would be raised. On the other hand, there was also concern that non-Māori would react negatively to being force-fed *te reo Māori*, which they could not understand.

Nevertheless, there was still a lack of evidence to show that "broadcasting has an impact on language revitalisation" (Hollings, 2005, p. 115). Successive governments remained unsure how best to meet their Treaty of Waitangi obligations with the funding that they have to allocate. To some degree this uncertainty was resolved in the publication of a report to the New Zealand Treasury by Grin and Vaillancourt (1998), who put a strong case for broadcasting being one of the most efficient ways of achieving language use and revitalisation. Consequently, the government of the time put money aside for a dedicated Māori television station. This station was opened in March, 2004. The Māori Television Act (2003) detailed that the station had to:

> ensure that during prime time it broadcasts mainly in te reo Māori; and ensure that at other times it broadcasts a substantial proportion of its programmes in te reo Māori; and ensure that, in its programming, the Service has regard to the needs and preferences of children participating in te reo Māori immersion education; and all persons learning te reo Māori; and provide broadcast services that are technically available throughout New Zealand and practicably accessible to as many people as is reasonably possible. (cited in Middleton, 2010, p. 162)

Currently, a few mainstream broadcasters also include some *te reo Māori*. For example, news on Radio New Zealand National is broadcast in *te reo Māori* at 6.27 am, 8.45 am, 5.45 pm, and 6.45 pm (www.radionz/national/programmes/waatea). There is little or no *te reo Māori* heard on commercial radio. Although there has been an increase in the use of *te reo Māori*, particularly in salutations on mainstream television programmes, the perceived disregard by many broadcasters to the correct pronunciation of Māori words raises the ire of many Māori. In an opinion piece, Willie Jackson (2009), a Māori activist and broadcaster, wrote:

> Māori language is mispronounced daily not just on small radio or TV channels but on networks like Radio NZ, TVNZ and TV3. And while top broadcasters like Simon Dallow, John Campbell and National Radio's Geoff Robinson make a big effort, their attempts are negated by fools like Leighton Smith, Paul Henry and Michael Laws, who don't give a damm about pronouncing Māori correctly.

The resistance of some non-Māori to listening to *te reo Māori* on the television may be lifting with the advent of Māori television and its popular programming choices. The 2006 ANZAC day dawn service beamed from Gallipoli received enormous ratings, which included many non-Māori. Anecdotally, it also seems that programmes provided with English subtitles allow non-speakers not only to hear the language, but also to understand what is occurring. For example, the 1960s American children's comedy *Mr Ed* was revamped into *te reo Māori* and is broadcast at 8 pm on Wednesday evenings in prime time. Replacing the language relocated *Mr Ed* to New Zealand. On the whole, the programme has been well received by both Māori and non-Māori. The following reaction is typical of those found on blogs, twitter, and facebook.

> A horse is a horse, of course, of course ... But is it a horse ... if it's in Māori??? The nation of New Zealand does an excellent job of making the most of its bilingual status of making sure that both English and Māori languages are fairly evenly presented in most mediums. Nowhere did this seem more obvious lately when we discovered the 60's sitcom, Mr Ed was being broadcast on the Māori television channel. (Spelling corrected) (from http:regator.com/p/153060911/mr_ed_maori/)

In deciding how broadcasting can be used for the revitalisation of the language another tension concerns meeting the different needs of learners as well as proficient speakers. For a revitalisation effort to be successful, television and radio broadcasting must support both groups to gain meaning from *te reo Māori* programmes. In 2006, a survey was undertaken to see how often radio and television in *te reo Māori* were utilised (Te Puni Kōkiri, 2008b). It found that proficient users of *te reo Māori* were the most frequent listeners. When users who had limited proficiency were asked why they did not listen, they responded that they could not understand what was being said.

Table 8.2 shows the number of hours that Māori accessed *iwi* (tribal) radio in the week before the survey was taken.

By 2006, Māori television was able to reach homes in 90 percent of the country. In another survey, 71 percent of Māori adults responded that they had watched at least one television programme in *te reo Māori* in the preceding four weeks (Te Puni Kōkiri, 2008b). Of these viewers, 28 percent watched Māori language programmes

Table 8.2 Duration of listening to *iwi* radio during the week

	Percentage of listeners	
Listening duration	2001 (percent)	2006 (percent)
Less than an hour	19	24
1–5 h	45	47
6–10 h	14	13
11–20 h	9	6
21–30 h	6	5
31–40 h	3	2
41 h or more	3	3

everyday. These results combined with the results from Table 8.2 suggest that there is an audience for programmes broadcast in *te reo Māori*.

The Use of the Mathematic Register on Māori Television

What remains unclear is whether programmes make use of the mathematics register, either in the form of transliterations or the new terms promulgated by the Māori Language Commission in the 1990s. Hollings (2005) lamented the lack of a methodology to determine the impact of broadcasting on the revitalisation of a language. As a first step, we have monitored *te reo Māori* programmes to determine whether the mathematics register was used. If the mathematics register was not used extensively, then the aim of revitalisation to support the increase in the number of functions served by *te reo Māori* is not going to be realised through the use of broadcasting.

In 2009, a range of radio and TV broadcasts in Māori was listened to over a two-week period. Instances of the mathematics register were recorded, and the results presented in Tables 8.4, 8.5, 8.6, and 8.7. The television items included a mixture of news and current affairs and programmes for children and youth. It was anticipated that children's programmes designed for those attending Māori-immersion schools were the most likely to include the newer terms in the mathematics register. More Māori youth had been documented as watching Māori television programmes for entertainment than any other age group (Fryer, Kalafatelis, & Palmer, 2009). Therefore, entertainment programmes designed for this age group were monitored. The youth age group included recent graduates of Māori-immersion schooling, and thus they would be able to interpret the mathematics register if it was found in these programmes. Table 8.3 sets out the programmes that were monitored for the use of mathematics register.

The frequency of different terms varied from just a couple of instances to over a hundred. In Tables 8.4, 8.5, 8.6, and 8.7, the frequency of terms used in different mathematical topics is shown in different tables beginning with number terms.

Generally, whole-number terms were by far the most common mathematical terms used across the programmes, particularly numbers between zero and 100. These terms were coined during the early 1800s with the advent of trade between Māori and European. There were also many references to numbers between 1000 and 10,000. Most of these numbers referred to years, for example, *I haere ia ki Taupo i te tau 1965* (he/she went to Taupo in 1965) and quantifying measurement terms – *6500 heketea o te whenua e watea ana* (6500 ha of land is available). Very large numbers such as a million or billion almost always were used in reference to money.

There were only two references to fractional numbers, one the recently coined term for a half (*haurua*) and the other to the transliterated version – *hawhe* (half). For a long time, Māori used the words *hawhe* and *koata* (quarter), which were borrowed from English. With the development of the teaching of mathematics in the medium

Table 8.3 Programmes, amount of times monitored, and brief description of programme type

Programme	Length	Times monitored	Description
Miharo	1 h	6	Designed for five- to eight-year-olds, it is specifically aligned with school curriculum areas.
Te Kaea (Māori news)	30 min	13	Nightly news programme.
Tau Ke	30 min	6	Screening between 4 pm and 5.30 pm, it is aimed at children attending *kōhanga reo* and *kura kaupapa Māori.*
Te Tēpu	30 min	2	Current affairs with some of the country's best practitioners of *te reo Māori* sharing their views on local, national, and international issues with presenter Wai horoi Shortland.
Whare Puoro	30 min	3	New Zealand musicians performing entirely in *te reo Māori.*
Pukoro	30 min	3	Educational show for children.
Kupuhuna	1 h	3	A language-based game/quiz show.
Haa	30 min	7	Daily info-tainment magazine programme for young teenagers.
Kaimanga	30 min	3	Music show.

of Māori, *hau*, an old word that meant fraction in the sense of over and above a complete number, is now used to express fractions in the mathematical sense. The use of fraction terms came first and then time terms were based on these.

The time terms were popular in news items about different events. Common time terms were not new. Although Keegan (2005) suggested that the new terms for the days of the week and the months of the year had gained some acceptance in Māori language broadcasting, it seems that it very much depended on the individual broadcaster which versions of the terms were used. New terms were created for the days of the week and the months of the year by the Māori Language Commission. However, they have not been well received by older speakers of *te reo Māori* (Harlow, 2003). Keegan (2005) related the story of a *kaumatua* (elder) who, when talking to students in the local *kura kaupapa Māori,* would chide any student using new terms for the days of the week and months of the year, because he did not agree with them. There is some rationale for the months of the year, in that they originated from a specific dialect of Māori and therefore can be considered traditional. Nevertheless, Harlow (2003) made some valid points in his scathing commentary on the abandonment of the borrowed terms, which have been in long use, for the recently invented pseudo-traditional days of the week, such as *rāhina* (moon-day) for Monday. As noted by Keegan (2005), these days are based on the seven-day Judeo-Christian tradition and are calques of French words that would have originally come from Latin and transferred into English after the Norman invasion of 1066. Given that traditionally Māori

Table 8.4 Number terms and their frequency in Māori television programmes

Term	Frequency	Examples	Translations
Ordinal numbers	37	*I tae tuatoru mai*	She/he came in third
		Ko te mea tuarua. . .	The second thing.
		Ko au te tuatahi	I'm the first.
		Tokorima. . .	Five (people – toko indicates that it is people who are being counted).
0–100	110	*62 (t)ōku pakekeināianei * (not good Māori)*	My age is 62 now.
		Kerēwa te tokorua rā	That couple (two people) over there are clever.
		Kua mau kāpehu tatou, hei ārahi i a tātou ki ngā tai e whā.	We've bought a compass to guide us to the four sea coasts.
100–1000	18	*102 ngā tauira ki te kura*	There are 102 students in the school.
		200 m te roa o te kaukau	The swim is 100m long.
1000–10,000	65	*8 850 m te teitei o te maunga*	The height of the mountain is 8850 m.
		1 450 taara te utu hei. . .	In order to . . .. the cost is $1450.
		6 500 heketea o te whenua e wātea ana	There are 6500 ha of land available.
		3 754 mita te teitei o tērā maunga	The height of that mountain over there is 3754 m.
		I tēnei tau 2009	In this year, 2009.
		I toa ia i ngā whakataetae i te tau 2007	She/he won the competition in the year 2007.
		I te tau 2006 ka whakaputa i tōna kōpae Pākehā	In the year 2006, she/he put out her English-version disc.
		5000 taara ka tukua ki te kura ka toa.	$5000 will be given to the school that wins.
		Mō ngā whakataetae 2010	For the 2010 competitions
		I haere ia ki Taupō i te tau 1965.	He went to Taupo in 1965.
10,000–million	10	*2.5 miriona taara te utu hei. . .*	The cost to . . . is 2.5 million dollars.
		10,000 mano taara i tohaina ki. . .	Ten thousand dollars was distributed to . . . .
		Kotahi miriona taara	One million dollars
		Piriona	Billion
Fractions	2	*Haurua i te hāora ka huakina te "Kete Panui"*	Half past the hour, "Kete Pānui" will be opened/started.
		Hāwhe	Half
Operations	2	*Whakarau 24*	Multiply (by) 24.
		I tātaitia ngā tāngata. . .	The (number of) people were calculated.

Table 8.5 Measurement terms and their frequency in Māori television programmes

Term	Frequency	Examples	Translations
General terms	1	*Te teitei o Maungawhau*	The height of Mt Eden
Time terms	75	*Ia pō, ia wiki ka whakaatuhia tētahi mea papai o tēnei tau*	Every night, every week something good from this year was shown.
		I tēnei pō	Tonight
		He wiki kei te toe!	There is (only) a week left.
		Hoki mai āpōpō.	Come back tomorrow.
		Kua tae ki waenganui o te wiki	(We've) arrived in the middle of the week.
		Hei te mutunga o tēnei marama	At the end of this month
		Inanahi rā i tū te . . .	Yesterday the . . . . was held.
		Transliterations	
		Paraire	Friday
		Wenerei	Wednesday
		Māori Language Commission terms	
		I tēnei Rātū, 1 o Hakihea	This Tuesday, the 1st of December
		I te marama o Hongongoi. . .	In the month of July
		Tēnei Rāpare ataahua rawa atu	This incredibly beautiful Thursday
		Kohitātea	January
		Rāmere	Monday
Metric terms	2	*170 kirokaramu te taumaha o taua manu*	The weight of that bird is 170 kg.
		74 kiromita te tere o te rere i ia haora tā tēnei manu.	The speed of the flight on this bird per hour is 74 km.

Table 8.6 Space and geometry terms and their frequency in Māori television programmes

Term	Frequency	Examples	Translations
Shape	11	*He whīra ōrite ki tētahi tapawhā.*	A field (shaped) like a square
		He ōrite ki tētahi tapawhā.	Just like a square
		Anei he tapatoru rite.	Here's an equilateral triangle
		Anei he tapatoru hangai.	Here's a right angle triangle
Location	10	*Huri noa i te motu*	All around the country
		He tata rawa koe ki a ia.	You are really close to her/him
Compass points	35	*Nō ngā topito katoa o te motu*	From all the compass points [corners] of the country
		He haumuri	A north wind
		Mai i te tonga	From the south
		Mai i te raki	From the north
		Kua tau ki te Tai Raki	Has descended on the North Coast
		Kua haere ki runga	He/she has gone south [down]

Table 8.7 Probability terms and their frequency in Māori television programmes

Term	Frequency	Examples	Translations
Probability	20	*Tērā pea ka toa koe i tēnei whakataetae.*	Perhaps you'll win this competition
		Ākene pea ka tīnihia taua āhua	Maybe that situation will change
		A tērā tau pea ka toa tōku kura	Next year, perhaps my school will win
		Mahi matapōkere noa	Doing it blindly/randomly

did not use "weeks" as a measurement term from time, there was no equivalent for the days of the weeks.

Metric measurement terms were used sparingly, and the two examples came from the programme *Miharo*. Metric terms are transliterations. As they are labels, it would make little sense to try to find a more Māori set of terms that shows the same relationship between prefixes.

The use of shape terms came from the children's television programmes, but even so there are very few of them, given that there were over ten hours of viewing these programmes.

In broadcast about the weather, the new directional terms were used but were highly localised. Compass points were related to the speakers' locations. The major compass points were based around the new terms of East–West. When speakers came from the north, *muri* (behind) was used. Up meant to go south as in going to the head of the fish and relates to the fact that the north island of New Zealand was deemed to be a fish, hooked and brought to the surface by Māui. The canoe that he and his brothers were fishing in was the south island.

Many of the terms are used in everyday language. For example, there were many examples of the use of *tērā pea* (perhaps). Yet, their inclusion in general conversations suggests that these terms represented only a loose relationship with the probability understandings taught in schools.

Over the two-week period, 27 and a half hours of television were monitored. It is disappointing to see that the variety of mathematical terms used is quite limited. If a comparison was to be made with the mathematics register terms used in the Māori newspapers of the 1930s, the main differences probably would be in the terms used in relationship to the days of the week and months of the year, as well as the compass directions. Nevertheless, the variety of terms is likely to be of a similar number. Although the use of the older terms for the days of the week and months illustrates the resistance to the use of the new terms, it is interesting to see other transliterations such as *hāwhe* still being used almost two decades after the Māori Language Commission recommended that these terms be replaced. The use of different terms with the same meaning can be confusing for language learners. It also illustrates the tension around the use of technology and ensuring the integrity of the language. It may be fortunate for the language that only two examples of fractions occurred over the monitoring time, of which one was a transliteration.

The lack of variety in the range of terms used is perhaps not as surprising as it first seems. In-depth analysis of statistical information on modern broadcasting is often relegated to being too hard for listeners or viewers to understand, and presenters will often stop these types of conversations before interviewees can explain their point. It would be interesting to do a similar analysis of English-medium broadcasting to see how often the mathematics register occurs across a similar range of programmes. If the mathematics register is to be used in fulfilling a set of non-school functions, then arguably the wider community actually needs to value such discussions, not just in regard to the media. Until this happens, it is unlikely that there will be an increase in the use of mathematics register in the wider community.

The Use of *Te Reo Māori* by Students Once They Finish Their Māori-Medium Schooling

When students finish their schooling in *te reo Māori*, there are possibilities for them to continue to use it as a main language in social, work, and study situations. As discussed in the first part of the chapter, interactions in the medium of Māori can only occur if a number of factors come into alignment, including having conversational partners and opportunities for discussions (Te Puni Kōkiri, 2004). The information that we received from two ex–Te Koutu students indicates that *te reo Māori* still remains a significant language of communication for them, even though they also use English to fulfil some language functions. Nonetheless, it seems that they do not engage in much mathematics that draws on their knowledge of the mathematics register.

Using Te Reo Māori for Further Study

In relationship to the possibilities for further study in New Zealand in *te reo Māori*, teacher education is the main opportunity for completing a university degree in *te reo Māori*. These programmes are discussed in more detail in the next chapter. There is very little research into students' experiences of doing university content courses in *te reo Māori*.

The exception is a paper by Keegan (1998) on the teaching of computing through the medium of Māori. In 1993, as part of the challenge presented by the co-ordinators of the BA in Māori Studies to other departments at Waikato University, the computer science department began offering an introductory course in *te reo Māori*. The average mark received by students completing this course was similar to that gained by students completing a complementary paper in the medium of English. Keegan (1998) commented on how he felt that the nature of the class was more collaborative than the English-medium equivalent. Reminiscent of the development of the mathematics register, in an earlier article, Barbour and Keegan (1996) discussed the difficulties in translating many of the computing terms into

te reo Māori. Many of the students, especially in the first year, commented on the difficulties of learning a large amount of new *te reo Māori* terms in one semester. Although the paper was originally run over the same time period as the English-medium one, in 1996 the paper was spread over a whole year to enable students who were both learners of *te reo Māori* and computing to get longer time to adjust to the material. This resulted in a significant increase in the average mark gained by the 1996 cohort of students (Keegan, 1998). In 1996, these students were briefly questioned about their opinions of the paper. They felt that:

- There was a strong support for the course due to the fact that it was in Māori, thus was supporting the Māori language.
- The course was beneficial to potential teachers, who will need this information in Māori when arriving in total immersion situations.
- It also was needed by the younger generation who would arrive with a stronger Māori language base.
- It proves that the Māori language can survive in new environments.
- Students who were learning the language had another environment where they could consolidate what they have learnt in a language course. (Barbour & Keegan, 1996)

Of the two ex–Te Koutu students, only one had gone on to do further study. This young man had completed his secondary schooling in Canada, attended university in the United States and then had done further study in New Zealand. All of this study was done in English. Nevertheless, even five years after he had left Te Koutu, he drew on his Māori to think mathematically: "I was studying a degree in Māori Development which involved Accounting and Finance and I must admit I would do the equations speaking in Māori" (ex-Student1, Survey, 2011).

In 2006, after he had spent one year in Canada, he explained in an interview his strategy for completing word problems:

> If I'm thinking right, then you have a word equation and then I translate it into Māori and then of course you are going to get the numbers right. Like, you are going to say two has to be taken away from this number and this number and this number. So then once I read that part in Māori I sort of just write the numbers and if it's minus or multiply or such and such, and then I mean because numbers you can read in any sort of language, right? (ex-Student1, Interview, 2006)

Although he was aware that his translating could introduce errors through mis-translation, he was able to use the numbers, which were the same in both languages, as a bridge for his thinking between English and *te reo Māori*.

Even if students from Māori-immersion schooling do not continue their education in *te reo Māori*, some of them are likely to continue to think in Māori. Yet, the transfer to a new language of instruction was not simple. In 2009, when the previously mentioned student was asked about the circumstances in which he would talk about mathematics with friends, he said that they did not talk about mathematics as

such in *te reo Māori*. However they did spend a lot of time talking about the difficulties of moving from learning mathematics in *te reo Māori* to learning mathematics in English. In the 2006 interview, he gave an example of this difficulty:

Tamsin: And is it harder to learn something new through English than if you were learning it in Māori?

Ex-Student1: Māori being my first language I would say yes to that. I'm not saying I'm not used to learning anything in English but it's having sort of 11 years of experience in maths [learning in *te reo Māori*] and one thing that's different is there are words in English that I cannot identify you know if I think the words in Māori. And when I think of words in Māori that may mean that, for that reason, sometimes it just doesn't fit and looking in the dictionary doesn't help either because words in English aren't sometimes in the Māori dictionary.

Tamsin: So give me an example.

Ex-Student1: Okay, this may sound funny, but hey as I told you earlier that I've been 11 years here right at the *kura* and suddenly going over there. For the first maths class I did not know what a square root was because in Māori we've always learnt it as *pūtakerua* right so that's one of the examples of the difference between the English.

Tamsin: How did you overcome that problem with the square root?

Ex-Student1: I'm trying to remember. Well at first I sort of thought to myself you know I can do this without asking anybody, so you know then the teacher goes "Okay you'll have to square root this number and square root this", so I sort of got the idea that "Okay, well if you're going to do this to this and this to that, square root this is the equivalent of square root that then I was thinking well maybe it's *pūtakerua* so I used that for the beginning and then when we finally got our test results back it worked out that I was right so that's how I sort of found out".

Given that most students from Māori-medium schools do not have much opportunity to continue their education in *te reo Māori*, some language support is required by these students when they begin to learn in English. As these students often have good conversational skills in English, they risk having their language-learning needs going unrecognised. Further education facilities, such as universities, are responding to this need.

Using Te Reo Māori at Work

The possibilities for using language at work depended very much on what the work was. If there were others who had good *te reo Māori* skills and the work being done required *te reo Māori*, then students regularly used this language to communicate.

When the context was a predominantly English one, *te reo Māori* might be used for thinking but not for communication with others. In the 2001 survey of the health of *te reo Māori*, Te Puni Kōkiri (2004) found that just over 50 percent of proficient speakers were likely to use Māori most of the time in the workplace, whereas less than 15 percent of non-proficient speakers used it most of the time. The numbers had increased slightly when the 2006 survey was undertaken (Te Puni Kōkiri, 2008a).

The strong *te reo Māori* language skills of Te Koutu students meant that several of them ended up working in Māori television. In the 2011 survey, one ex-student wrote: "At the moment I'm working on a children's program called PUKORO on Māori Television, and on the program we sometimes teach preschoolers how to count and measure" (ex-Student2, Survey, 2011). This workplace actively supported the use of *te reo Māori* and only employed presenters who were proficient in the language.

To use the mathematics register requires a purpose. For this young man, his role as a presenter meant he was aware that he was using aspects of the register in teaching preschoolers. Unless the mathematics that young adults are doing matches what they know mathematics to be from their experiences at school, then perhaps they do not always recognise the sorts of mathematics that they do in their work.

When these young adults were not working in a Māori industry, they often used different languages for thinking mathematically. For example, the first ex-student wrote about the mathematics he used in his work, "I was a Cashier performing customer services in the tourism industry so handling the money and doing money transactions I used English and sometimes Māori and sometimes Spanish" (ex-Student1, Survey, 2011). By this stage, he was fluent in all three languages and used whatever language came to mind when he was completing the calculations. This is not dissimilar to what others have reported about choosing a language for doing mathematics. In research on multilinguals' choice of language for doing calculations, Dewaele (2007) found the following:

> Frequency of general use of a language appeared to be a very strong predictor of use of a language for mental calculation across all 5 languages. Clearly, a constant use of a language can make that language become the inner language used for cognitive operations. Two participants, Meral and Elisabeth, who used their L1 and an LX with equal frequency in their daily lives, reported that they performed arithmetic operations with ease in either language, and that the language choice tended to be dictated by the situation. (p. 368)

The environment, in which students who had completed Māori-immersion education worked, influenced whether *te reo Māori* was a language of communication or a language for thinking. The sort of work that they were required to do also influenced their awareness of using the mathematics register.

Using Te Reo Māori for Socialising

Young people in the age group 15–24 years are documented as spending more of their time socialising than any other age group (Te Puni Kōkiri, 2004). Therefore,

understanding the languages used in this socialisation is an indicator of how successful *te reo Māori* is being used outside of school settings.

For both our participants, *te reo Māori* was the language they used when communicating with their immediate family as well as with their extended family on their mother's side. These family members were all fluent in *te reo Māori,* and so it was the natural language of choice. Te Puni Kōkiri (2008a) reported that 28 percent of children or dependents lived in households where there was at least one Māori speaker, and therefore opportunities existed for intergenerational language transmission. This is a very small proportion of the population, given that there is also a need for the adult with *te reo Māori* proficiency to want to pass these skills on to the younger generation. It would seem that these two young people were brought up in a situation where they had opportunities to learn *te reo Māori*, not just at school but also from their extended family. This is likely to have had an impact on their proficiency levels. "[O]ver 80 percent of the people who could speak Māori 'well' or 'very well' said that adults had spoken to them in Māori during their childhood" (Te Puni Kōkiri, 2004, p. 21). At the time the survey was taken, 2001, this did not include adults who had attended Māori-immersion schooling.

As well in Rotorua, many of the adults that these young people socialised with used *te reo Māori* as their main language for communication. This is probably one of the few geographical areas in New Zealand where this is the case (Te Puni Kōkiri, 2004). The proportion of Māori in the population is high in this city, and connection to the tourism industry means that *te reo Māori* skills are valued. When asked in the survey about his use of *te reo Māori* for thinking, ex-Student2 wrote "All the time really!! *He ngāwari atu māku te whakaaro i roto i te reo Māori, i te mea kua tupu ake au i roto i te reo Māori*". (It's easier for me to think in Māori, because I grew up in an immersion situation). However, ex-Student 1 is now working overseas and so has few people in his immediate circle of acquaintances with whom he can converse in Māori. It was only through contact with his family that he used his Māori regularly.

From the very small sample of ex–Te Koutu students, it would seem that *te reo Māori* remains a viable language for them to use, even if it has mostly become an inner language for thinking with the limited number of conversational partners in the different fields of their lives. The ex-students felt that because they had leant mathematics in *te reo Māori* for a long time, it came more naturally when they had to think mathematically. However, the more engagement in mathematics in an English-speaking environment, the more they were able to use their mathematical understandings to switch between languages and gain fluency in the English mathematics register.

Meeting the Challenge of Having *Te Reo Māori* Spoken in the Community

How *te reo Māori* can become a language of choice in the wider society in New Zealand is not a simple challenge. There are a large number of factors that need to interact to support the use of this Indigenous language within a predominantly

English-speaking general population. The situation is summarised well in the following quote:

> It is likely that there will be a range of conflicting forces within individual speech networks, some of which support the threatened language and some which support the majority language. The challenge for language revitalisation is to ensure that the forces that favour the use of the threatened language are able to predominate in a significant number of speech networks, to the point where there is a critical mass of people who *can and do* use the threatened language. (Te Puni Kōkiri, 2004, p. 22)

Broadcasting in *te reo Māori* provides a variety of opportunities for the language to be used. Yet it seems that only limited aspects of the mathematics register are being used. If the aim of revitalisation is for the language to fulfil a variety of functions, then opportunities may need to be provided which specifically support such a specialised register. Although *Miharo* was advertised as a programme specifically aligned to the school curriculum areas, very little of the mathematics register was used in this programme. However, it did provide the only two instances of the use of the metric system. The lack of high-level discussions about mathematics in the media is not just an issue in Māori broadcasting, but is a situation that also occurs in the English media. Listeners in any language are not expected to understand much mathematics or statistics. The only way that this situation is likely to change is if attitudes to mathematical discussions in general are changed.

On the other hand, it seems that graduates of Māori-immersion schooling would continue to use *te reo Māori* in a variety of ways once they are operating as young adults in the wider world. Therefore, there is hope that when more of these young adults graduate, the critical mass of *te reo Māori* speakers will see it become the language of choice, enabling more conversations about a range of topics to occur.

The challenge posed by the desire for everyday use of *te reo Māori* is being acted upon. It is recognised as a challenge, but there is no clear path yet available for resolving it. Increasing numbers of Māori-immersion graduates may have a greater impact than any other outcome.