MINISTRY OF EDUCATION

Te Tāhuhu o te Mātauranga

Te Poutama Tau Evaluation Report 2006

Research Findings in Pāngarau for Years 1-10

He Mihi

Ko te reo te manawapou o te Māori
Mā te kōrero te reo e ora ai
Mā te ora o te reo ka rangatira.

Ko te reo te waka kawe i te wairua me te whakaaro Māori, e whakatinanatia ai ngā āhuatanga katoa o te ao Māori. He taonga tuku iho te reo Māori. He reo, he mana, he wairua, he whakapono, he tikanga tō tēnā tangata, tō tēnā iwi, tō tēnā rohe. Mā te reo Māori rawa e whakahua, e kawe, e whakamārama te huhua noa o ngā tikanga Māori. Mā te mātau o te ākonga ki te reo Māori, ka mārama tōna huarahi ki te ao Māori, tōna mahi i roto i te ao Māori.

Ko te rumaki te tino ara whakaako reo Māori ki ngā ākonga. Ko te reo Māori hoki te reo e kawe i te pāngarau, te kaupapa o tēnei rangahau. Nō reira, tēnei te mihi atu ki ngā wharekura ki ngā kaiwhakaako e whakaako i te pāngarau ki ō tātau tamariki mokopuna. Tēnā koutou kua whakaae mai kia uru ai ki tēnei rangahau. He mōhiotanga nō mātau ki ngā taumahatanga kei ō koutou pokohiwi ki te whakaako i te kaupapa nei te pāngarau mā te huarahi o te reo Māori.

Ko te tino wawata o tēnei rangahau ka whai hua kia hiki ake te taumahatanga, kia pai hoki ngā hua mō ō tātau tamariki mokopuna kei ngā wharekura. Ki te kore, he moumou wā, he moumou kaha.

He mihi ki te rōpū tautoko i te rangahau nei, ki a Ben Mason rāua ko Trist Rewiti.
He mihi hoki ki Te Tāhuhu o te Mātauranga, nāna te whakaaro me te pūtea kia haere tēnei rangahau. Nō reira, kia kaha ki te whakatutuki i tā rātau e hiahia ai.

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Te Poutama Tau 2006: Trends and Patterns

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This paper reports on the analysis of the 2006 data from the Māori-medium numeracy project, Te Poutama Tau. In general, student performance improved throughout 2006. However, performance on the addition, subtraction, and proportion domains was somewhat disappointing, particularly progress at years 3 and 4. Additionally, there is still a proportion of students who made minimal stage gain. Analyses of patterns of performance and progress over time from 2003 to 2006 show there have been positive longitudinal trends in most areas of the Number Framework. Students also made greater progress in the earlier stages relative to their ages. Significantly, the longitudinal trends show that, where there have been areas of concern, additional focus on these areas in subsequent years has improved performance.

Background

The New Zealand Numeracy Development Projects (NDP) were developed in response to concerns about the quality of mathematics teaching and as a result of the achievement of New Zealand students in the Third International Mathematics and Science Study (TIMMS) (Garden, 1996, 1997). Although Māori-medium kura did not participate in the TIMMS study (the study was only available in the medium of English), the Te Poutama Tau project was subsequently developed in recognition of the fact that the teaching of numeracy is a complex area and that teachers of mathematics in the medium of Māori require support. The primary aim of the Te Poutama Tau project is to improve student performance in pāngarau (mathematics) through improving the professional capability of teachers. The first Te Poutama Tau project began in 2002 as a pilot and was further extended into a range of Māori-medium kura the following year (Christensen, 2003). Te Poutama Tau is based upon the Number Framework developed for New Zealand schools (Ministry of Education, 2006a). The Framework provides a clear description of the key concepts and the progressions of learning for students. In the absence of a wide range of Māori-medium resources to assist teachers in the interpretation of the Māori-medium national curriculum statements, the Te Poutama Tau professional learning programme provides significant support for teachers who are teaching mathematics in the medium of Māori.

Teachers from 31 schools participating in Te Poutama Tau during 2006 provided data for this paper. Students were assessed individually at the beginning of the programme, using a diagnostic interview, and again at the end of the year (Ministry of Education, 2006b).

The aim of this paper is to examine the following questions:

- What overall progress did students make on the Number Framework in 2006?
- In which areas of the Framework did students perform well in 2006 and in which areas did they perform poorly in 2006? Why is this so?
- How do patterns of performance and progress of students involved in the 2006 project compare with the 2003, 2004, and 2005 patterns?
- What areas of the Framework have they performed well or poorly over the four years? Why is this so?

Method

The results for each Te Poutama Tau student, classroom, and school are entered on the national database (www.nzmaths.co.nz). The database shows the progress that students have made on the Framework between the initial and final diagnostic interview. The time between the two interviews is about 20 weeks of teaching. Schools can access their own data on the national database to establish targets for planning and reporting purposes for the subsequent year(s). Teachers can use the data to group students according to ability and use activities that will support students in both strategy and knowledge development.

Participants

The following summaries of the data were restricted to only those students with both diagnostic interview results. In 2005, 496 students completed both the initial and final diagnostic interview and in 2006, there was complete data for 1153 students.

The low number of students recorded as participating in 2005 was due essentially to a range of issues around data entry. The redesigned database at the end of 2004 made it difficult to identify Te Poutama Tau schools. If participating teachers did not enter data into the language fields, there was no easy means of identifying the participating Māori-medium kura. English-medium schools that participated in the Te Poutama Tau project also had to tick a box identifying the data as Te Poutama Tau data. A number of schools failed to do this and consequently were not identified.

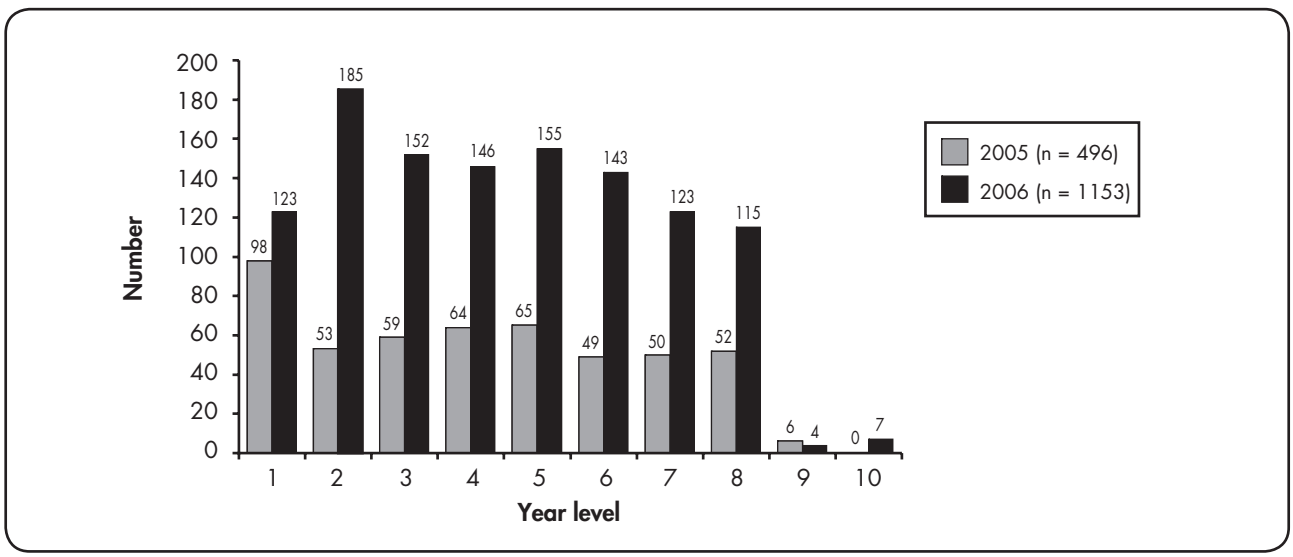


Figure 1: Distribution of Te Poutama Tau students across year levels

Overview of Student Progress 2006

Progress of students in the Te Poutama Tau schools was very positive in the areas of NID, fractions, grouping, and place value. In previous years, the results in these areas have not been as positive (Trinick & Stevenson, 2005, 2006). However, as a key component of the professional learning programme in 2005–2006, Te Poutama Tau facilitators and teachers gave particular attention to these areas. Proportion continues to be a challenge, particularly when students are in transition to stage 5 (early additive). The behavioural indicator for this stage requires students to find a unit fraction of a number mentally using addition facts, that is, $\frac{1}{3}$ of 12 as 4 + 4 + 4 = 12. The issue may be the strategy itself. This will need to be considered in future studies.

For the two forms of number-word sequencing, students make positive progress in the earlier stages, but there still appears to be an issue around the "large" numbers at stages 5 (early additive) and 6 (advanced additive), as noted in earlier studies (Trinick & Stevenson, 2005, 2006). However, there were positive stage gains in numeral identification. Hopefully, this will translate into more positive results for number sequencing.

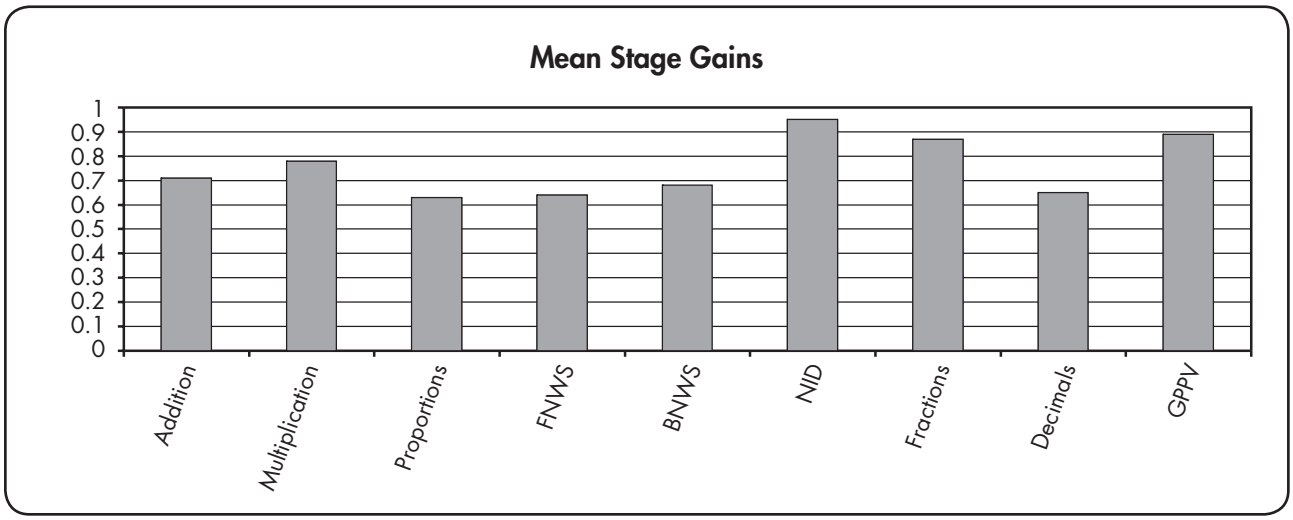


Figure 2: 2006 mean stage gains across the Number Framework

Student Achievement and Year Level

The graphs in Figure 3 on the following pages show variation in the mean gain for each domain of the Framework across the year levels. For example, students at years 0–1 made a mean stage gain of 1.25 for proportion and at year 3, a mean gain of 0.26 (Figure 3.3). There were no clear patterns common to all domains of the Framework. However, there are patterns within a number of related domains, particularly knowledge domains.

Strategy Domains

Although positive for addition and subtraction in the early stages (Figure 3.1), there is a significant slow down in later stages. This is due to a number of factors, including the complexity of upper levels and the number of students in the older year groups (6–8) who are already at stages 5–6.

There were no mean stage gains for multiplication for year 1 students and large gains for year 2 (Figure 3.2). This can be explained by the low numbers of students at years 1–2 who were tested using the multiplicative test items. The majority of years 1–2 were tested using Uiui A (NumPA) where there are no test items for multiplication. It is quite likely that the few year 2 students who made large gains were the high achievers. The results for proportion can be explained similarly. There were large stage gains at years 0–1 and at year 2 for proportion (Figure 3.3). However, there were only eight students who were tested for proportion in these year groups, and it is likely that these students may well be high achievers. There is a large dip in progress at year 3, where approximately 80 students had both initial and final data entered.

Knowledge Areas

In FNWS, BNWS, and NID, there is significant growth in the earlier years, with a similar pattern of regression in later years. This is not surprising, considering these areas are closely related. In order for students to count forwards or backwards or locate numbers, they need to be able to identify

numbers. The regression can be attributed to a number of key factors. For example, a number of students in the older age groups may already be at the upper stages. It is also important to note that numeral identification (Figure 3.6) as a separate data section is only part of diagnostic interview A, so students who proceed beyond test A to tests E or U will not register mean stage progress in NID. Figure 3.6 therefore only shows progress for students who were tested using test A. NID continues to be a critical aspect in the upper stages but has been subsumed as part of ordering numbers. As already stated, in order for students to count forwards or backwards or locate numbers, they need to be able to identify numbers.

In general, there were positive results for fractions across the year groups (Figure 3.7). As noted earlier, this has been an area of focus for facilitators and teachers in the Te Poutama Tau project in 2006. However, the very positive results for the years 0–1 students can also be explained by the low numbers of students tested and the fact that they were likely to be the high achievers. In general, there were positive results across the GPPV and basic facts domains (Figure 3.8). One of the problematic areas in basic facts seems to be around the division facts at stage 7 and common factors and multiples at stage 8 (Figure 3.9).

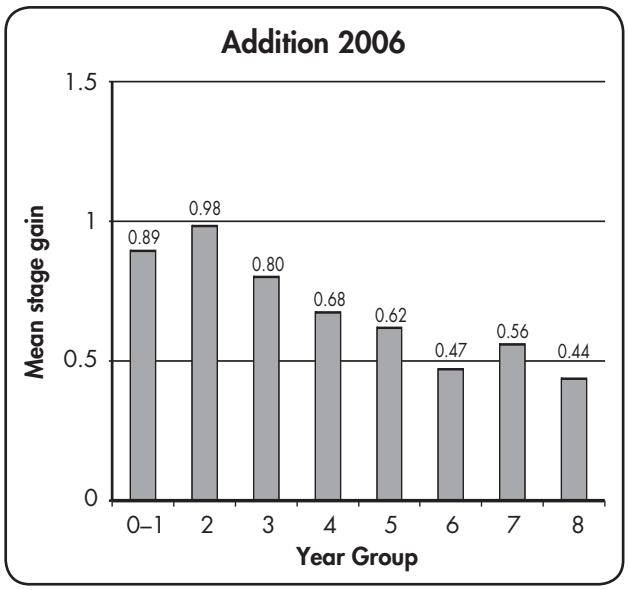


Figure 3.1: Mean stage gain for addition and subtraction

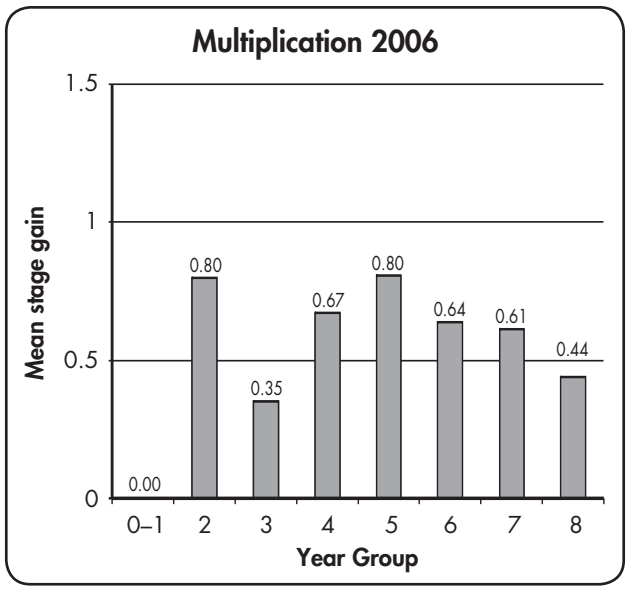


Figure 3.2: Mean stage gain for multiplication and division

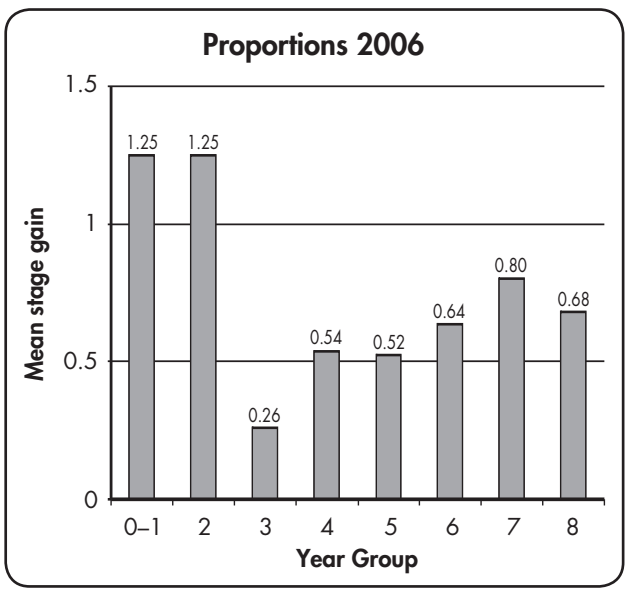


Figure 3.3: Mean stage gain for proportions

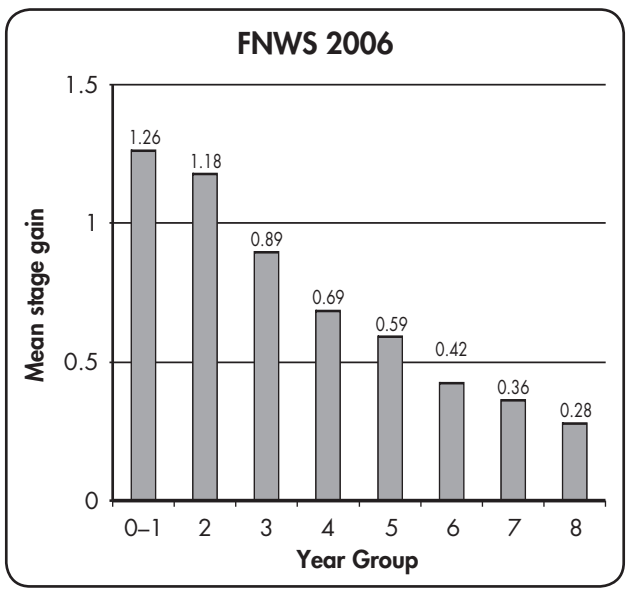


Figure 3.4: Mean stage gain for forward number word sequence

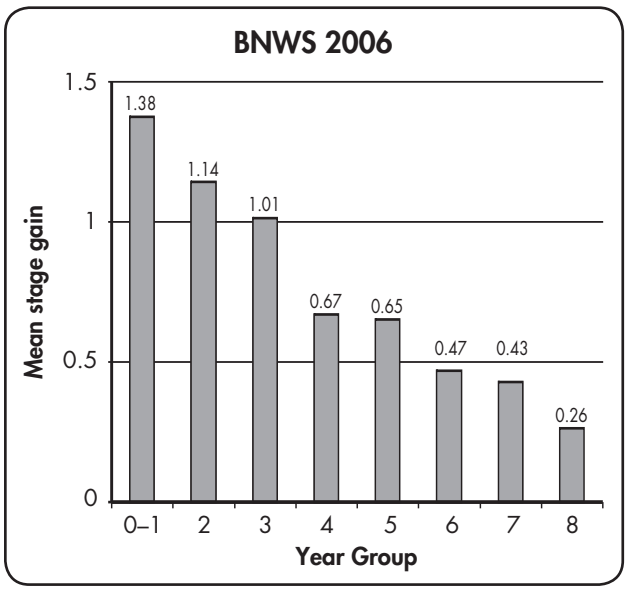


Figure 3.5: Mean stage gain for backward number word sequence

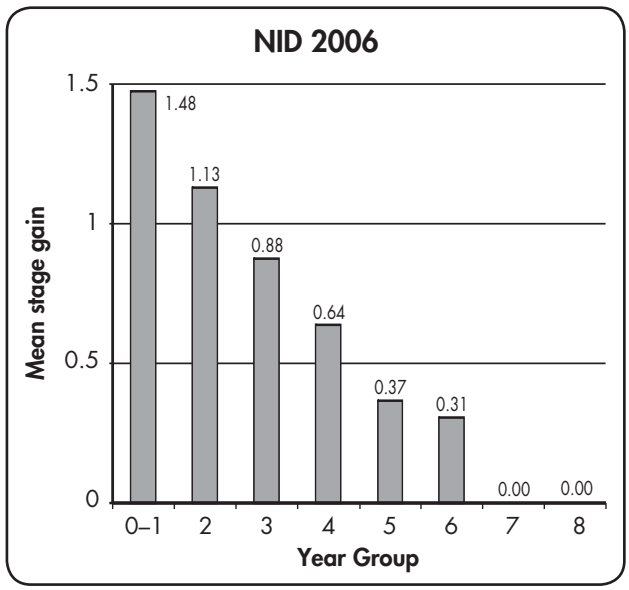


Figure 3.6: Mean stage gain for numeral identification

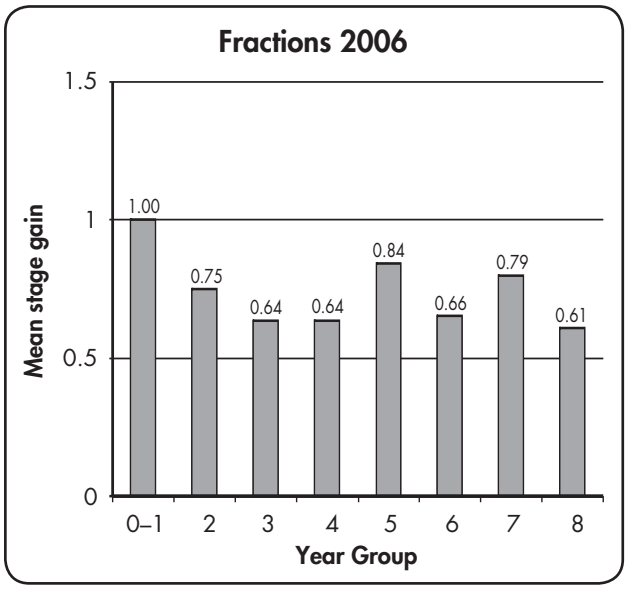


Figure 3.7: Mean stage gain for fractions

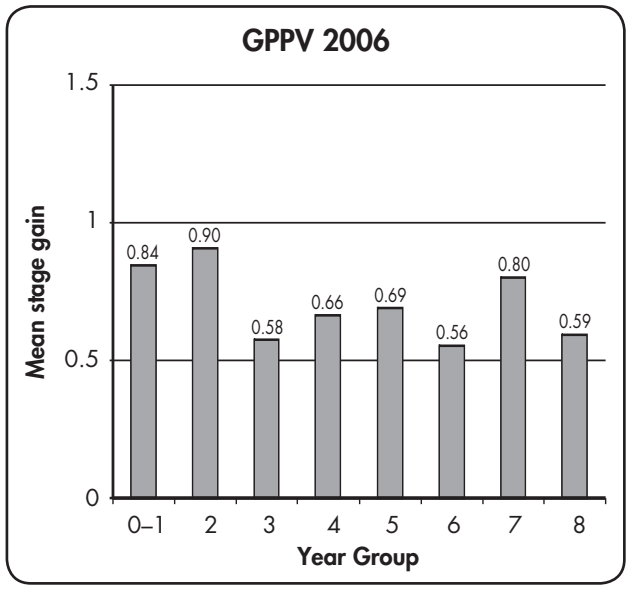


Figure 3.8: Mean stage gain for grouping and place value

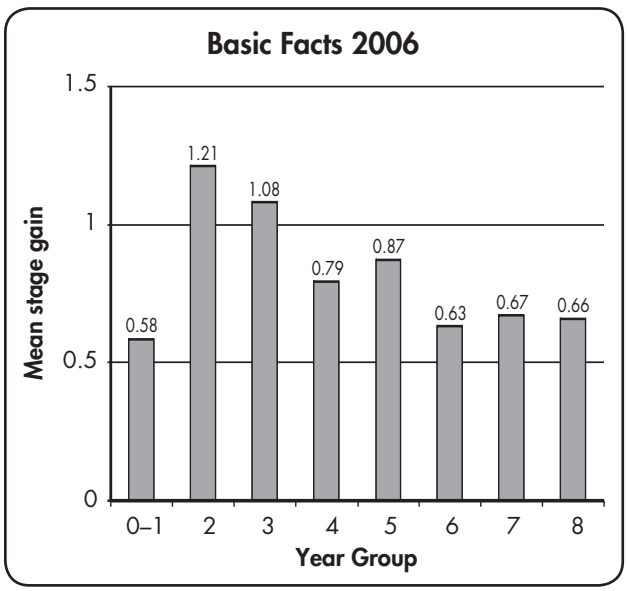
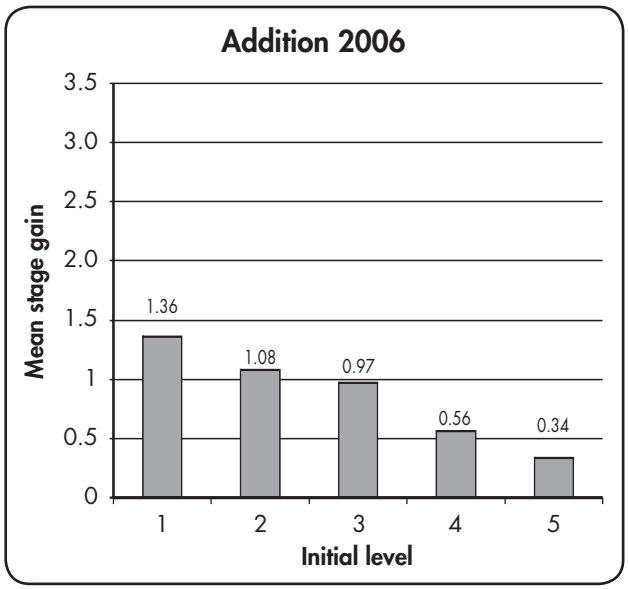


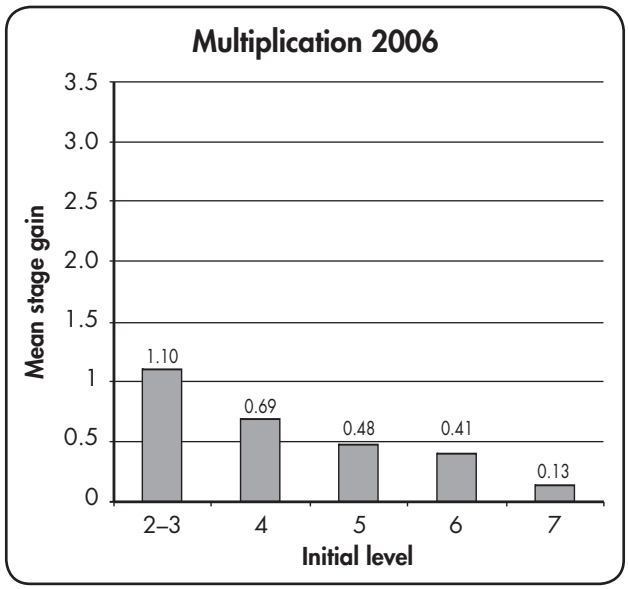
Figure 3.9: Mean stage gain for basic facts

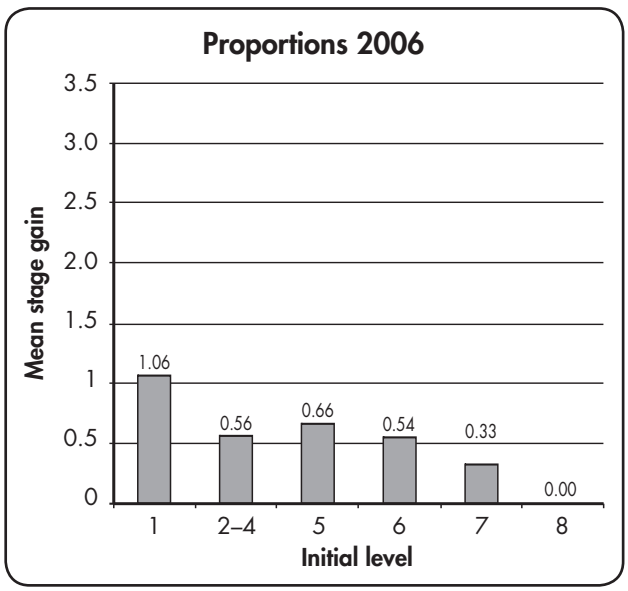
Student Achievement and Initial Stage Assessment

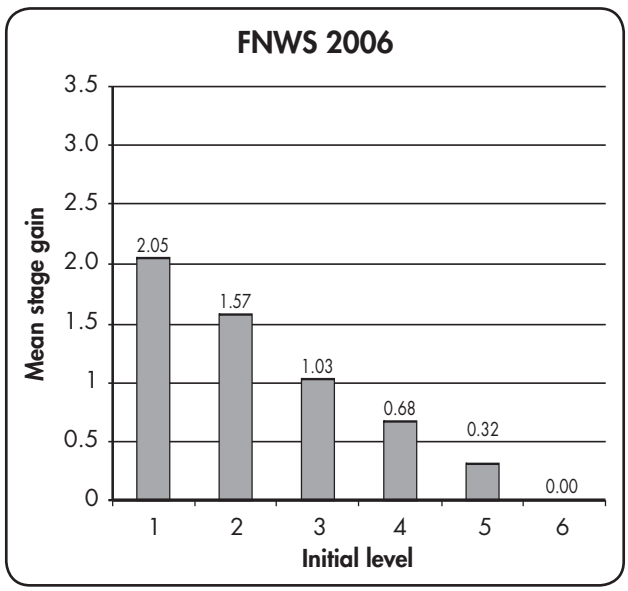
The graphs below (Figure 4) show the variation in the mean gain and initial stage level for each domain of the Number Framework. For example, students who initially tested at stage 1 for addition and subtraction made a mean stage gain of 1.36. Students who initially tested at stage 5 made a mean 0.34 stage gain. As with previous years, there was no clear pattern common to all aspects of the Framework. The domains of addition, multiplication, FNWS, BNWS, and NID showed a "diminishing returns" pattern, where advancement was more difficult for children at successively higher year levels. It is important to note that the stages on the Framework do not constitute an equal interval scale because the increments at the lower end of the Framework are smaller than those at the upper. Students tend to progress through the lower stages more quickly.

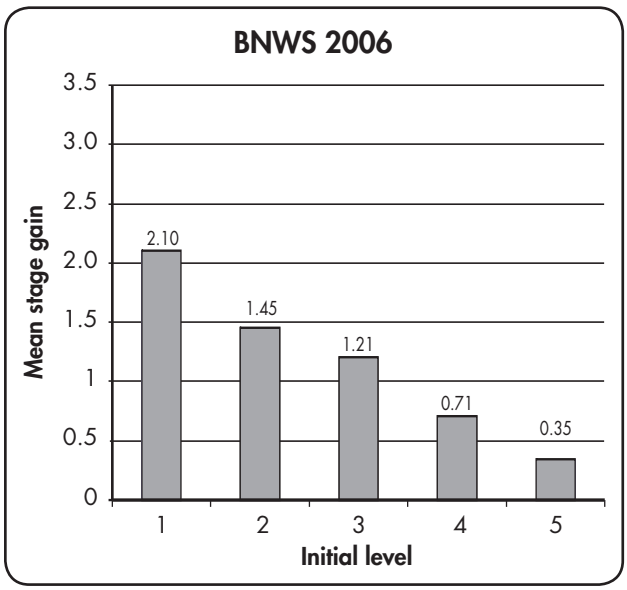
However, aspects such as fractions and GPPV are showing positive gains through most of the levels. It is particularly pleasing to note the very positive stage gains for fractions for students at stage 7.

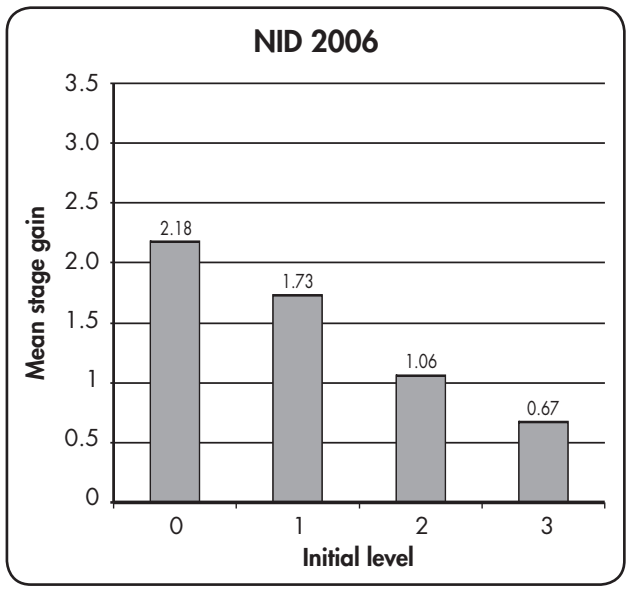


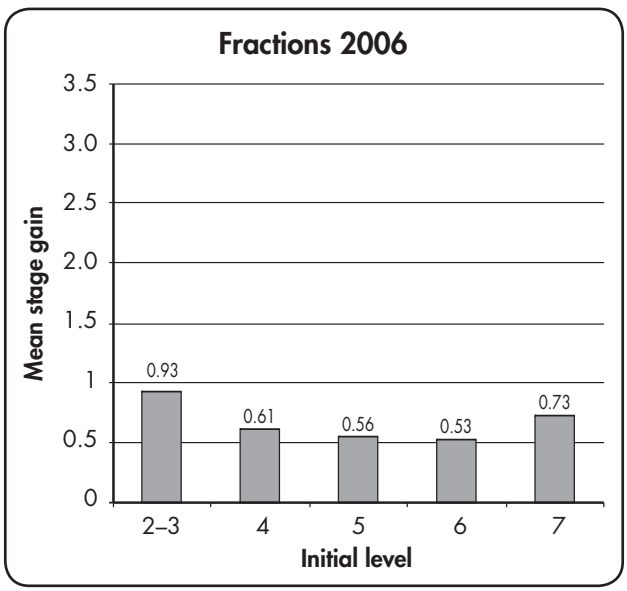


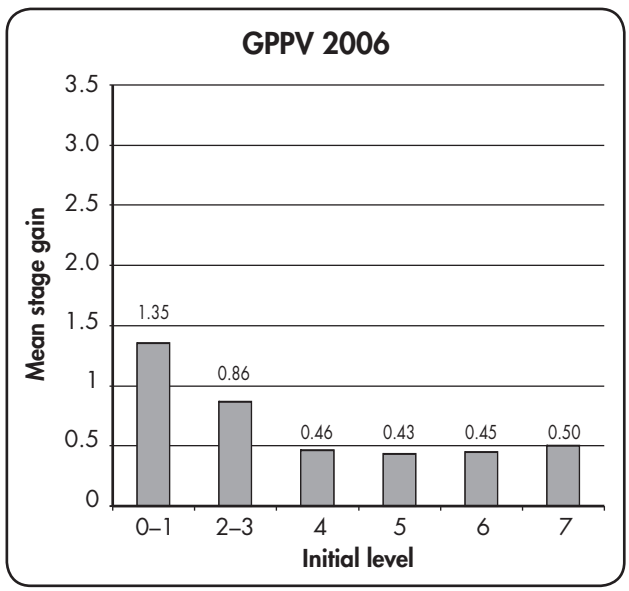












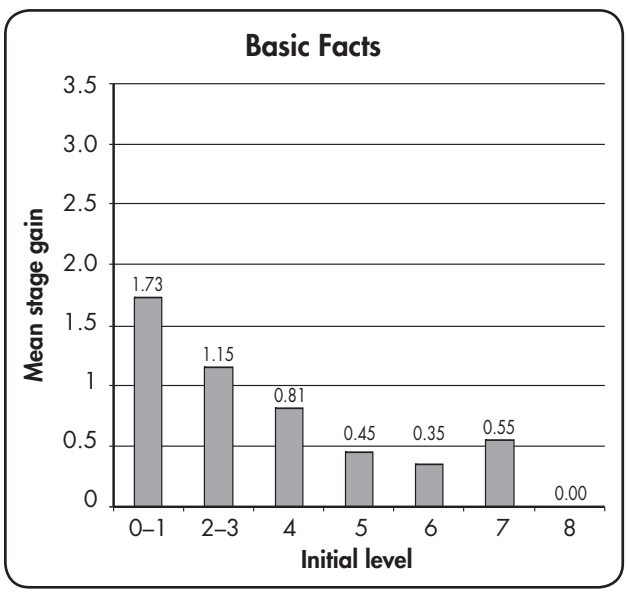


Figure 4: Mean stage gain and initial stage level

Reporting of Student Achievement Data

Individual schools and classrooms can use similar charts to analyse their own students' data. These types of charts can help teachers to identify patterns and trends at an individual school level, but teachers need to be aware that for small samples of students these charts can be very misleading. A useful addition to the NDP are guidelines for the use and reporting of student achievement data using expectations (www.nzmaths.co.nz/numeracy/Principals). This guide assists kura and teachers to identify students "at risk" and high achieving students.

Longitudinal Patterns of Progress

This section examines patterns of performance over four years of implementation of Te Poutama Tau. Overall, the trend in student progress for 2006 was relatively consistent with 2005 results. With the exception of addition and subtraction, there have been positive longitudinal trends in most areas of the Framework. One possible explanation for the regression in addition/subtraction is that some students have achieved stage 6, in other words, a ceiling affect. Over the last three years (2003, 2004, and 2005), there was evidence of improved stage gains for proportions, numeral identification, and decimals. From 2005 to 2006, there is a slight regression in fractions and multiplication. This is partly due to students moving into the higher stages, which are more complex.

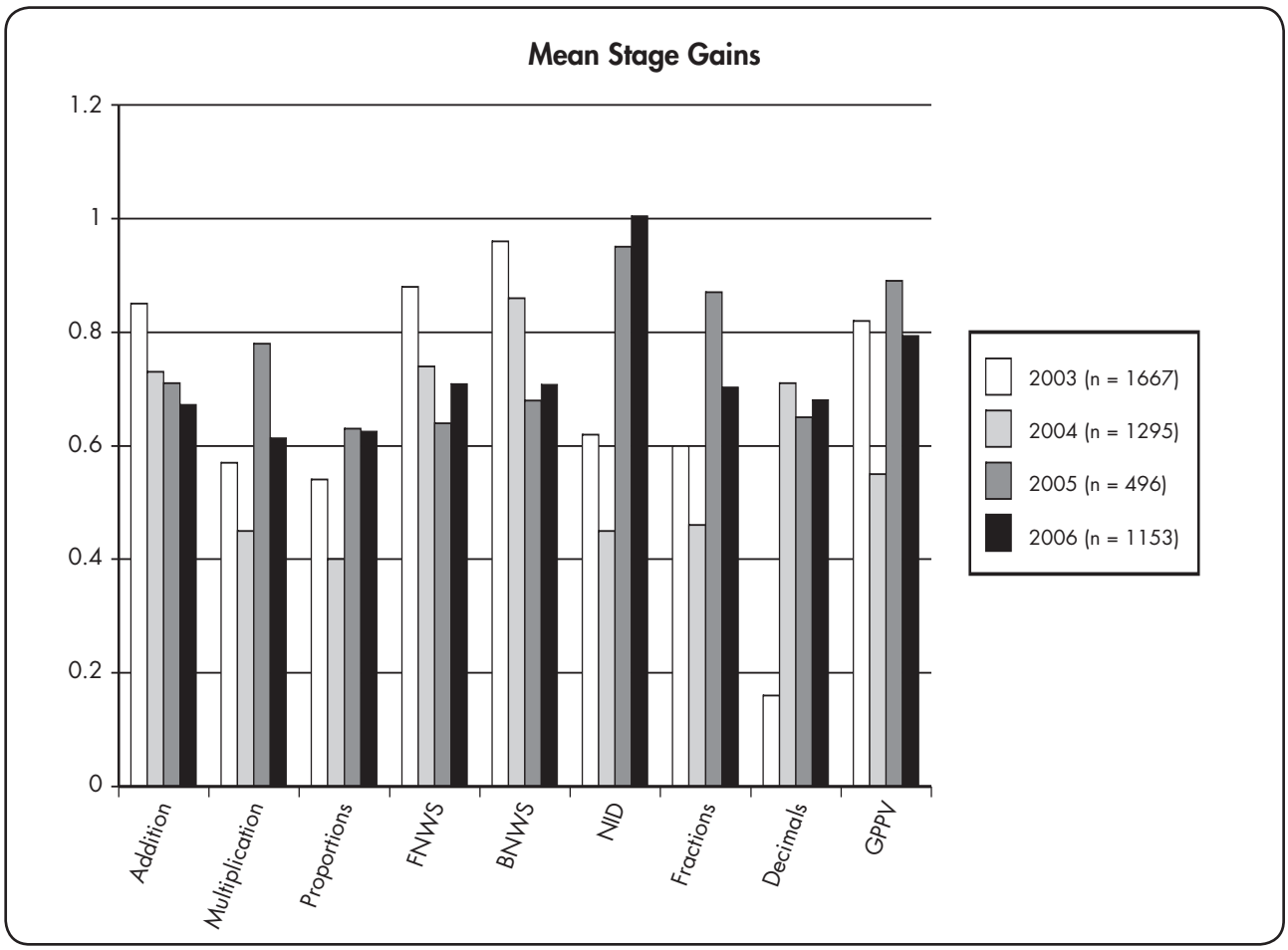


Figure 5: Mean stage gains across the Number Framework

A number of interesting trends show up in the following table. If the 2004 results are compared with the 2006 results (larger data sample sizes), the change difference in most of the domains of the Framework is greater. This in part can be attributed to increased teachers' and facilitators' confidence in the delivery and management of the project. In GPPV, for example, the trend is a 0.55 gain in 2004, a 0.89 gain in 2005, and a 0.79 gain in 2006. As noted in earlier studies (Trinick & Stevenson, 2005, 2006), grouping and place value underpin many of the key ideas of the Framework. It is not clear why there was a slight regression in addition and subtraction. As noted earlier, concern was raised in 2005 at the less than positive stage gain in NID. However, with a concentrated focus by teachers and facilitators on this domain, the mean stage gain of 1.00 is very encouraging.

Table 1
Comparison of Change Between Initial and Final Test Results

		2004 (n = 1295)			2005 (n = 427)			2006 (n = 1153)		
	Mean	Initial	Change	Final	Initial	Change	Final	Initial	Change	Final
Strategy	Addition	4.1	0.73	4.85	3.7	0.71	4.22	3.69	0.67	4.36
	Multiplication	2.1	0.45	2.58	2.6	0.78	3.16	2.63	0.61	3.25
	Proportions	2.1	0.40	2.41	2.5	0.63	2.92	2.49	0.63	3.12
Knowledge	FNWS	4.7	0.74	5.46	4.0	0.64	4.55	4.04	0.71	4.75
	BNWS	4.4	0.86	5.27	4.0	0.68	4.66	4.11	0.71	4.82
	NID	3.0	0.45	3.46	2.9	0.95	3.78	3.24	1.00	4.25
	Fractions	1.9	0.46	2.31	2.0	0.87	2.69	2.04	0.70	2.74
	Decimals	2.6	0.71	3.26	2.8	0.65	3.41	2.87	0.68	3.55
	GPPV	2.5	0.55	3.08	3.0	0.89	3.83	3.41	0.79	4.20

The following figure shows how the average for the final results for all domains varies across the year levels for 2003–2006. From year 4 onward, the trend is reasonably consistent. Large mean stage gains were made in the earlier year levels in 2006. However, as noted earlier, it is important to interpret these results cautiously because the stages do not constitute an interval scale. The large gains in the early years of 2006 can be attributed in part to the high mean stage gain in multiplication and proportions (Figure 3.3). However, the number of students who made the gains was very low. There has consistently been a dip at year 3 followed by a slight rise at year 4. It is at this point where many students are transitioning from using counting strategies to part–whole.

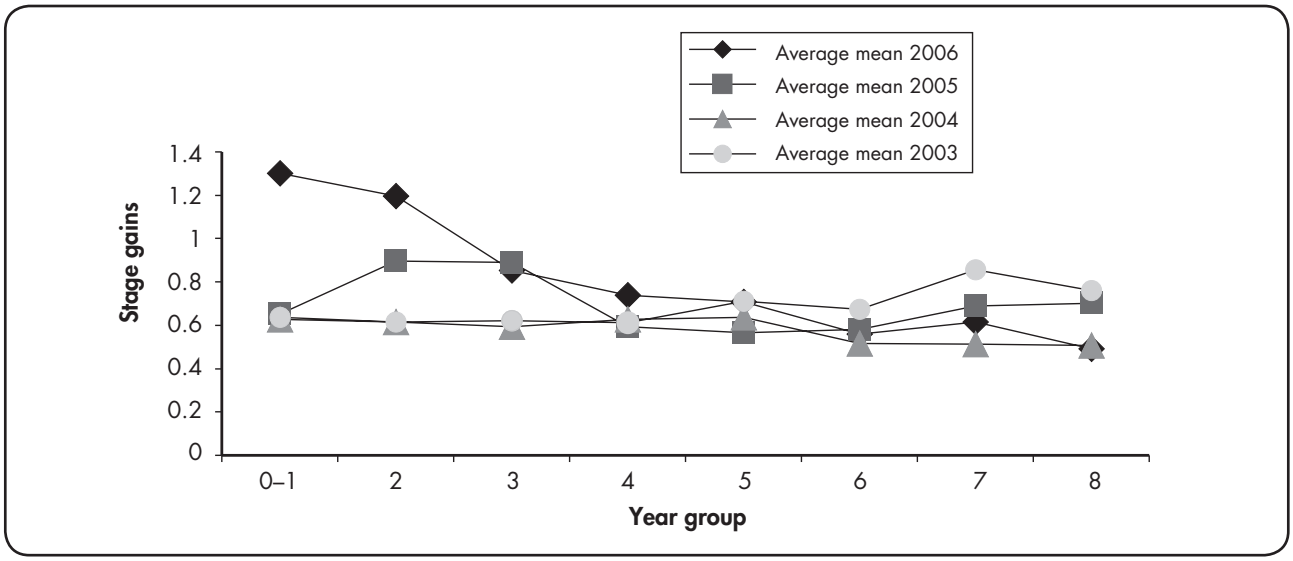


Figure 6: Comparison of students' average mean stage gain across years 2003, 2004, 2005, and 2006

Summary

As the corpus of data collected grows as a result of the Te Poutama Tau project over the last five years, there are many more questions raised, for example, the interrelationship between the domains, that is, the relationship between multiplication, division, fractions, and proportions. In order to carry out many fraction and proportion tasks, students need effective division and multiplicative strategies. Considerable work also remains in identifying the relationship between language proficiency and student achievement in Māori-medium mathematics. The following recommendations arise from the research that has been discussed in this report and discussions with Te Poutama Tau facilitators for particular focus in 2007:

- Focusing on older students who have made minimal stage gain, for example, year 4 students who have not progressed beyond the advanced counting stage for addition (these are year 5 in 2007)
- Focusing on the teaching of addition and proportion, particularly with the 2007 year 4 students
- Investigating the impact of the Te Poutama Tau project on Māori-medium mathematics generally, for example, investigating students' progress in other strands and/or using alternative tests, such as asTTLe
- Continuing to investigate the relationship between Māori language and mathematics
- Incorporating algebraic thinking into the Te Poutama Tau project. While it is unclear what the algebra objectives in the Marauatanga Pāngarau really mean for the younger students, the trickle-down effect of these objectives are clear: kura tuatahi teaching must focus greater attention on preparing all students for challenging wharekura mathematics programmes, particularly NCEA. Thus, "algebraic thinking" has become a catch-all phrase for the mathematics teaching and learning that will prepare students for successful experiences in algebra and beyond.

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"Who helps me learn mathematics, and how?": Māori Children's Perspectives

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Ahakoa rongo, kāore i rongo
Ahakoa kite, kāore i kite

This study set out to explore the perspectives of Māori children attending kura kaupapa Māori schools. Forty year 5–8 children in three kura were interviewed individually in te reo Māori to ascertain their perspectives towards learning pāngarau/mathematics. The findings show that the children were aware of a number of sources of support, should they need help with their mathematics. The children had strong views about their teacher's role, strategies for learning, and working with others.

Background

In traditional Māori society, education was oral, thematic, and holistic (Barton & Fairhall, 1995; Riini & Riini, 1993). Children enjoyed the support of a variety of their community members to fulfil their potential for learning (Hemara, 2000). As educational patterns have shifted to a Western form of schooling, Māori children's underachievement in mathematics has become evident (Barton & Fairhall, 1995; Forbes, 2002; Garden, 1996, 1997; Knight, 1994; Ohia, 1995).

Initiatives have been developed and implemented to help address Māori underachievement in mathematics. These include Te Poutama Tau, a professional development programme for teachers in te reo Māori based on the English-medium Numeracy Development Projects (NDP). This programme has been implemented in some Māori immersion settings.

The views of Māori children can contribute to greater understanding about their learning in mathematics. Some Māori children in English-medium schools have provided insights regarding teacher support while learning mathematics (Taylor, Hāwera, & Young-Loveridge, 2005). However, research that considers Māori children's perspectives about learning mathematics in kura is limited. Children are major stakeholders in the business of learning in our schools, so it is important to listen to their understandings about their experiences (Forman & Ansell, 2001; McCallum, Hargreaves, & Gipps, 2000; Rudduck & Flutter, 2000; Young-Loveridge, 2005).

Children often have clear views about who supports their learning at school (Phelan, Davidson, & Cao, 1992). The roles they assign their teachers can significantly impact on their experiences during classroom mathematics sessions (Taylor, Hāwera, & Young-Loveridge, 2005). For example, if children have a view that only the teacher possesses relevant knowledge about what should be done in class, they may wait for that information to be conveyed to them (Alerby, 2003). On the other hand, children will take an active role in their mathematics learning if they perceive their teacher to be a mentor rather than a transmitter of mathematical knowledge (Taylor, Hāwera, & Young-Loveridge, 2005).

Having a range of problem-solving strategies is very helpful for children's mathematics learning (Bucholz, 2004; Thompson, 1999; Young-Loveridge, 2006). According to some writers, teachers need to take note of and help children develop their own mathematics strategies for solving problems (Heuser, 2005; Scharton, 2004; Smith, 2002). Involving children in explaining, listening to, and reflecting on a range of strategies will help them make better sense of the mathematics they engage with (Zevenbergen, Dole, & Wright, 2004).

Communication has been a major focus in mathematics learning for some time (Anderson & Little, 2004; Hunter, 2006; Ministry of Education, 1992). In order for children to gain the most from their learning in mathematics, they need to have meaningful interactions with those around them (Ittigson, 2002; Lyle, 2000). However, expectations may need to be made explicit to children so that they appreciate the value and purpose of such interactions (Campbell, Smith, Boulton-Lewis, Brownlee, Burnett, Carrington, & Purdie, 2001; Hunter, 2006). According to Christensen (2004), student discussions in pāngarau/mathematics in Te Poutama Tau classrooms have tended to be limited to short responses to recall questions involving calculations.

Close relationships with others in class may affect Māori children's participation and learning (Bishop & Berryman, 2006; Bishop, Berryman, Tiakiwai, & Richardson, 2003; Macfarlane, 2004). Working co-operatively with others has long been deemed a useful strategy for learners of mathematics (Terwel, 2003; Kumpulainen & Kaartinen, 2004). Tasks that require co-operative learning and the social construction of mathematics ideas are thought to be helpful for Māori (Hāwera, 2006; Holt, 2001). An integral part of this is positive interdependence, where participants perceive that common goals can only be achieved when all members attain their personal goals. Such a process encourages the sharing and justifying of ideas and the resolution of conflicting perspectives and solutions and hence stimulates higher cognitive processing (Johnson & Johnson, 1999).

Although there is considerable research on children's views of their learning at school, there is a paucity of information about children's perspectives regarding whānau/family support for their learning of pāngarau/mathematics. Atkinson (1999) suggests that parents who wish to support their children in schools may need exposure to recent developments in order to work with teachers and children to raise mathematics achievement. Te Poutama Tau emphasises mental calculation and a range of non-algorithmic strategies in number activities. Such emphases may be different from those learned by parents and extended whānau.

The purpose of this study was to explore the views of Māori children attending kura kaupapa Māori schools or wharekura about their perceptions of the support they receive when learning mathematics.

Method

Participants

This study focuses on the responses of 40 year 5–8 Māori children in three schools. Two schools were kura kaupapa Māori, catering for students from years 0 to 8, and one was a wharekura with students from years 0 to 13. All kura had participated in Te Poutama Tau, the Māori immersion component of the NDP, for several years prior to the study. Half of the children were from a decile 1 kura, and half were from decile 5. Twenty-three of the children were female and 17 were male. Table 1 shows the composition of the sample by year level and highest Framework stage on Te Mahere Tau (The Number Framework; see Ministry of Education, 2007) in mid 2006.

Table 1
Composition of the Sample by Year Level and Highest Framework Stage

Year level	Yr 5	Yr 6	Yr 7	Yr 8	Total
Highest Framework stage					
3	1				1
4	1	1			2
5	4	2		3	9
6	2	3		5	10
7		2	10	4	16
8		1	1		2
Total number of children	8	9	11	12	40

Procedure

Schools were asked to nominate year 5–8 children from across a range of mathematics levels. Children were interviewed individually for about 30 minutes in te reo Māori in a quiet place away from the classroom. They were told that the interviewer was interested in finding out about their thoughts regarding their learning of pāngarau/mathematics.

The questions this paper focuses on were part of a larger collection of questions that the children were asked to respond to. The questions of interest here were:

- Ki ōu whakaaro, he aha ngā mahi ā tō kaiako hei āwhina i a koe ki te ako pāngarau?
  (How do you think your teacher helps you to learn mathematics?)
- Pēhea ētehi atu tāngata? Ka āwhina rātou i a koe ki te ako pāngarau? Ko wai? Pēhea?
  (What about other people? Do they help you to learn mathematics? Who? How?)
- Kei te kāinga ētehi tāngata hei āwhina i a koe ki te ako pāngarau? Pēhea tō rātou āwhina?
  (Are there people at home who help you to learn mathematics? How do they help?)
- He aha tō hiahia i te nuinga o te wā – me mahi ko koe anahe, me mahi rānei ki te taha o ōu hoa? He aha ai?
  (How do you prefer to work most of the time – by yourself or with your friends?)

Audiotapes of interviews were transcribed by a person fluent in te reo Māori. Transcripts were subjected to a content analysis to identify common ideas coming through in the children's responses.

Results

Children's responses to the questions have been organised according to the various themes emerging from the data. Some examples illustrating the range of responses have been recorded below. The code at the end of each excerpt identifies the child as well as gender and year level.

Teacher's Role

The children were asked how their teacher helps them to learn mathematics: "Ki ōu whakaaro, he aha ngā mahi ā to kaiako hei āwhina i a koe ki te ako pāngarau?"

The most common response from children was to refer to strategies that their teacher had taught them (see Table 2).

Table 2
Children's Views Regarding Teacher Help

Shows strategies	Mathematics skills	When difficult	Teacher's behaviour	No help	No idea
16	3	3	8	1	9

Shows strategies

Sixteen of the 40 children mentioned that the teacher helped mostly by showing them a strategy or strategies to do the mathematics. These children placed great reliance on the teacher to supply them with the way/ways to do the mathematics:

> Ka mahi ia tētahi pātai pāngarau i runga i te papatuhituhi. Ana, ka pātai ia ki a mātou pēhea ka mahi tētahi rautaki mō tēnei whakautu. Arā, ka tarai mātou, ara, ka tuhi ia tētahi rautaki kia mārama mātou ki tētahi rautaki rerekē mō taua pātai. Āe. (K4–f7)
>
> (He does some mathematics questions on the board, and he asks us how would we use a strategy for this answer. We try, and he writes another strategy so that we can understand a different strategy for that question.)
>
> A, ka whakaatu mai ia i ētahi rautaki kia māmā ake te haere mō te pāngarau, ... kore tahi noa iho, āhua toru, āe, āe. (K38–f7)
>
> (He shows us some strategies so that the mathematics is easier ... not just one, about three, yes, yes.)

Mathematics skills

Three of the children mentioned that their teacher helped them to develop particular mathematics skills:

> ... ki te kaute i ōku nama" (K15–m5)
>
> (... to count my numbers)
>
> Ina kāre koe i te mōhio i te rua whakarau rua, ka whakaako ia. (K29–f6)
>
> (If you don't know 2 x 2, he will teach you.)

When mathematics is difficult

Three others mentioned that the teacher helps when the mathematics is "difficult":

> ... ka āwhina a ia i a koe mēnā ka ngaro koe (K21–f5)
>
> (... helps us if we get lost)
>
> ... ka taea e ia ki te āwhina i a mātou i ētahi wā, mēnā e uaua te pātai (K13–f8)
>
> (...helps us sometimes when the question is difficult)
>
> ... kia mahi mai i ngā mea māmā ki ngā mea uaua (K45–m5)
>
> (...helps do the easy-to-difficult ones)

Teacher's behaviour

Eight children commented on the teacher's behaviour. The teacher was described as someone who:

kōrero ngātahi (K23–f7)
(talks with us)
ki te whakamārama i ngā, he aha mātou me mahi (K21–f5)
(explains what work we have to do)
te tuhi i runga i te papa tuhituhi (K20–m6)
(performs tasks like "writing on the board")
mahi i ngā mea uaua ake mōkū (K39–m6)
(provides me with "harder work")
ka tohatoha ngā kurū, ngā hints, āe, ki a mātou ... (K35–m7)
(shares clues and hints, yes, to us ...)

Teacher is no help

One child was adamant that the teacher did not help at all in his learning of mathematics (K14–m8).

No idea about the teacher's role

Nine of the children did not seem to have any view about how their teacher helped them with their mathematics learning. The idea of thinking about and discussing the role their teacher plays in their mathematics learning seemed to be something they had not previously considered.

Support from Friends

The children were asked about other people, whether or not they help them learn mathematics, and how: "Pēhea ētehi atu tāngata? Ka āwhina rātou i a koe ki te ako pāngarau? Ko wai? Pēhea?"

This gave them an opportunity to reflect on the contribution of their friends or peers.

Table 3
Children's Views Regarding Help from Others

Help from friends	No help from friends	No mention of help from friends
24	9	7

Help from friends

Twenty-four children mentioned that others in their class helped them.

Eleven of these 24 children said that their friends helped by showing them a strategy or a way to do their mathematics:

Ka whāki mai rātou pēhea te mahi. (K29–f6)
(They reveal to me how to do the work.)
Ka kōrero mai rātou he aha tētahi rautaki pai ake. (K19–f8)
(They tell me a better strategy.)

Four people viewed friends as peers who provided them with an answer:

Ka kī mai i ngā whakautu. (K36–m7)

(They tell me the answer.)

... te kī mai i ngā whakautu ... kāore i te pai, nā te mea e pīrangi ana au kia ako (K18–f8)

(... tell me the answers ... not good because I want to learn)

Three saw friends as people who were able to explain the work to them:

Mēnā kāre au i te mārama ētahi wā ka whakamārama rātou ki ahau. (K25–f7)

(If I don't understand, they will explain it to me.)

Four children saw friends as people they could work with:

Ka āwhina mātou katoa i a mātou. (K26–f8)

(We all help each other.)

Two of the 24 were not specific about how their friends helped.

No help from friends

Nine out of 40 children stated specifically that they received no help from their peers with their mathematics learning. In fact, five of these children were very clear in their view that they were so strong mathematically compared to others in their class that it was their peer group who expected help from them, rather than the other way round:

Ētahi wā ka whai rātou i ōku mahi. (K38–f7)

(Sometimes they follow my work.)

Kāo, ka hiahia rātou i ahau ki te whakaako i a rātou. (K40–f5)

(No, they want me to teach them.)

Ka whai rātou i ahau. (K17–f6)

(They follow me.)

No mention of help from friends

Seven of the 40 children made no specific mention of friends at school helping them with their mathematics.

Support from People at Home

Another question that children were asked to respond to was about people at home who help them learn mathematics, and how they help them learn: "Kei te kāinga ētehi tāngata hei āwhina i a koe ki te ako pāngarau? Pēhea tō rātou āwhina?"

Table 4
Children's Views Regarding Help at Home

Strategies	Mathematics skills	Questions	Various ways	Not sure how	No help
9	8	8	9	5	1

Thirty-nine out of the 40 children interviewed responded immediately that there were people at home who help them with their mathematics learning. These included mothers, father, grandparents, siblings, as well as uncles and aunties.

Strategies

Nine of these children commented on how people at home helped them with strategies to learn.

> Ka homai rātou te rautaki kia māmā ake. (K29–f6)
>
> (They give me the strategy so that it's easier.)
>
> Kāre rātou ka kī te whakautu, ka kī rātou ētahi rautaki mōku, āe. (K38–f7)
>
> (They don't tell me the answer, they tell me some strategies.)

Mathematics skills

Eight out of the 40 children were quite specific about the mathematics that those at home helped them with:

> Ka kore au e mārama i ngā mahi tau ā ira ... ka whakahoki ētahi mahi kāinga, ka āwhina rātou i a au. (K27–f8)
>
> (If I don't understand decimals ... I take home some homework, they help me.)
>
> Ki te kaute me ahau, and ki te whakaako i ahau he aha ngā tangohia me ngā whakarea me ngā honohono. (K21–f5)
>
> (To count ... to teach me subtraction, multiplication, and addition)

Questions

Eight children mentioned being asked to answer questions:

> Ka whiu pātai ki au. (K16–f6)
>
> (They ask me questions.)
>
> Ka whakaatu ia ētahi pātai, ā, ka whakautu au, and mēnā kāre he tika me haere tonu au kia whiwhi i te mea. (K42–m7)
>
> (She shows me a question, I answer it, and if it's not right, we keep going until we get the one.)
>
> A, ia rā whānau ka kī a ia, ka hoatu au ki a koe rima tekau tāra, mēnā ka taea koe te mahi i ēnei pātai tahi rau i roto i tēnei rā ... tino uaua, arā, ka awhi i ahau. (K39–m6)
>
> (On each birthday, he gives me $50 if I can answer 100 questions on that day ... very difficult and he helps me.)

Other

Two children talked about family members who gave them clues but not the answers:

> ... ka whoatu i ngā hints (K35–m7)
>
> (... gives hints)
>
> Mā te kī ko tēhea te nama tata ki te mea tika (K20–m6)
>
> (By saying the number close to the right one)

Five felt that they were given help generally with their homework. Two children mentioned that there was help at home for them, but they didn't use it.

Not sure how they helped

Five children were not sure how people at home helped them learn mathematics.

No help at home

Only one child said there was no one at home to help her.

Preferred Way to Work

Later during the interview, the children were asked how they preferred to work most of the time, by themselves or with friends: "He aha tō hiahia i te nuingā o te wā – me mahi ko koe anahe, me mahi rānei ki te taha o ōu hoa? He aha ai?"

Table 5
Children's Preferences Regarding Working Alone or with Friends

Always work with friends	Work alone except for difficult ones	Always work alone
16	8	16

Sixteen children out of 40 indicated that they would prefer always to work with their friends. Fourteen of these thought that this would be helpful for their own learning:

> Nā te mea ka taea rātou ki te āwhina i ahau (K11–f5)
>
> (Because they can help me)
>
> Ka taea koe te ako. (K23–f7)
>
> (You can learn.)
>
> He māmā ake. (K37–f7)
>
> (It's easier.)

The other two children felt that learning maths with others was helpful for their friends rather than for themselves:

> Kia mohio hoki ō hoa ki ngā whakautu (K24–m7)
>
> (So that your friends will know the answer)
>
> Kia pai ake, kia tūturu ōna mōhiotanga (K13–f8)
>
> (So that his/her knowledge is better and more secure)

Help with Challenging Mathematics Only

Eight children thought working with others was useful but only when working on "harder" or more difficult mathematics; otherwise it was better to work alone:

> Um, mēnā he tino uaua te pātai, ka haere ki tētahi o ōku hoa ki te mahi rautaki, āe, mēnā he māmā ngā mea katoa, āe, mahi ko koe anake. (K38–f7)
>
> (If it's a difficult question, I'll go to one of my friends to work on a strategy. Yes, if it's all easy, work by yourself.)
>
> Mēnā kāore koe e mōhio pēwhea te mahi pāngarau, taea te mahi tāu hoa taha, āe, mēnā e koi rawa koe, āe, taea te mahi tō ake taha. (K31–m8)
>
> (If you don't know how to do the mathematics, you're able to work with your friend. Yes, if you're really sharp, you can work by yourself.)

Sixteen out of the 40 children stated that they always liked to work alone, and a variety of reasons were given. Five felt that their friends talk too much:

> Mahi ko au anake ... ka kōrero rātou. (K14–m8)
>
> (Work by myself ... they talk.)

Five thought that their friends would "copy" or "steal their answers":

> Kia kore ia ka titiro ki ō mahi pāngarau, me te tinihanga (K15–m5)
>
> (So they don't look at your work and cheat)

Another five felt that there were other advantages to working independently:

> Kia taea ki te eke ki tērā taumata (K35–m7)
>
> (So that I can get to the next level)
>
> E pīrangi ana au kia mahi ko au anake, kia kore au e bored. (K18–f8)
>
> (I like to work alone so that I don't get bored.)
>
> Nā te mea, ētahi wā he āhua rerekē ngā whakautu, arā, ka whakamahi i taua whakautu engari ka hē, arā, he tika tōku, koirā te take ka mahi au ōku ake, nā te mea ina he hē, he pai. (K26–f8)
>
> (Sometimes the answers are a bit different, and when I use that answer it's wrong and mine was right. That's why I like to work by myself, because if it's wrong, that's OK.)

Only one of these children could not articulate a reason for preferring to work alone.

Discussion

It was pleasing to see from the children's responses that they were aware of a number of sources available to them, should they require support for their mathematics learning. Most children thought that there was help readily available for their mathematics learning, from their teachers, their friends, and/or their families.

Many children indicated that the teacher played an integral part in their mathematics learning by providing them with particular strategies and help when they were experiencing difficulty. The children seemed to regard their teacher as the person who was responsible for controlling and determining their mathematics programme. Their responses indicated that they thought very little input was required of them. Could this perception of the teacher's role and the consequent modes of participation by the children impose some limits upon children's mathematics learning?

Te Poutama Tau emphasises the need for children to learn a range of strategies to support the development of number ideas. The idea that there are different and acceptable ways of finding a solution was clear to these children. However, there was little evidence to suggest that children were being encouraged to generate mathematics ideas or strategies of their own (Heuser, 2005; Scharton, 2004; Smith, 2002). Communication with the teacher or peer group seemed to be restricted to explanations of strategies that had originated from the teacher. Like Christensen (2004), this study found that interactions in pāngarau/mathematics did not seem to involve the children in major discussions about key mathematical ideas.

Although the children had learned that there can be multiple strategies to reach solutions, none of them mentioned the possibility that these strategies could be the basis for in-depth problem-solving or investigative work that was academically engaging and mathematically challenging (Bastow, Hughes, Kissane, & Mortlock, 1984; Colomb & Kennedy, 2005; Maxwell, 2001; Ministry of Education, 1992; Terwel, 2003). It is clear that open-ended tasks that appeal to children's different experiences and levels of thinking are important (Ittigson, 2002; Terwel, 2003). According to *Mathematics in the New Zealand Curriculum* (MiNZC: Ministry of Education, 1992), such open-ended problems place more emphasis on the process of problem solving and require persistent and sustained engagement over a period of time (Bastow et al., 1984; Colomb & Kennedy, 2005; Maxwell, 2001). This approach to mathematics has been shown to be beneficial for Māori learners (Hāwera, 2006; Hemara, 2000).

In recent years, there has been much emphasis on mathematics learning as a social activity (Ernest, 1994; Hunter, 2006; Ittigson, 2002; Ministry of Education, 1992). However, the benefits of working co-operatively or collaboratively in mathematics (Terwel, 2003; Johnson & Johnson, 1999; Kumpulainen & Kaartinen, 2004) were not always apparent to these children. Although more than half of them

thought that it could be helpful to work with their friends, many expressed a strong preference for working by themselves on mathematics tasks for fear of distraction, being cheated on, or their individual progress being hampered. Some children recognised the advantages of collaboration when the mathematics was more challenging, wanting to share the responsibility for solving problems set by the teacher. Hunter (2006) argues that the benefits of working together should be made more explicit to children if they are to value co-operative and collaborative mathematical experiences at school. This is consistent with the notion of mathematics as a social activity and with Māori concepts of ako (reciprocal learning and teaching) and whanaungatanga (relationships) that enhance learning for Māori (Macfarlane, 2004). However, it is important to remember that the practice of discussing, reasoning, and playing with ideas when learning mathematics is not equally "natural" for all students (Lubienski, 2007). Teachers need to be aware that some students may need more support than others in adopting discussion-based approaches to their mathematics learning.

It was overwhelmingly clear that these children were aware of having strong support at home to help with their mathematics learning. This support involved giving children strategies, answering questions, and clarifying particular mathematics ideas. There was no evidence of conflict between the learning of particular mathematics strategies at school and the support that was available at home. This could indicate that the children have become accustomed to the idea that there can be more than one way to find a solution to a mathematics question and fully accept that notion. Families clearly have a powerful influence on children's learning. Could more opportunities be created to take advantage of this support to help address underachievement of Māori in mathematics? This might involve sharing recent initiatives and emphases in mathematics learning with whānau, thereby helping to address a key aspect of the NDP strategy; that is, strengthening links with the community (see Ministry of Education, 2001).

This study indicates that these Māori children participating in Te Poutama Tau think they have considerable support from teachers, friends, and whānau with their mathematics learning, should they want it. Teacher-taught strategies were viewed as the ultimate authority in the mathematics programme. Despite the emphasis on listening to and building on others' ideas in Te Poutama Tau, the children seemed to have few expectations that they needed to contribute to the construction of their own mathematics ideas. Many also seemed unaware of the possible benefits of collaborative learning, even though this has been a successful strategy used by Māori in earlier times (see Hemara, 2000).

Recommendations

This study has raised issues for educators of Māori children. Improving the mathematics achievement of Māori children is an ongoing focus. We suggest that the following ideas be considered:

- more exploration and development of ideas by children to enhance their ability to make sense of mathematics
- help for children to participate in and appreciate demanding mathematical discourse
- inclusion of more challenging problem-solving and investigative tasks
- utilising and building upon children's ideas for their mathematics programme
- ensuring that tasks requiring collaboration are included in mathematics programmes
- creation of more opportunities for the use of the strong whānau support available for mathematics learning
- further research to explore ways of continuing to enhance mathematics learning for Māori children.

Ngā Mihi

Hei whakamutu ake tēnei wāhanga o te rangahau, ka mihi ake ki ngā whānau, ngā mātua, ngā tamariki i whakaae kia uru mai ki tēnei rangahau. Mā te mahi pēnei ka mārama pai ai te huarahi, ka hiato ngā whakatupuranga.

Nō reira, ngā karanga maha, ka nui te mihi.

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Te Poutama Tau: Te Whakaako Pāngarau – Wharekura

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Executive Summary

The aim of this project was to carry out needs analyses of wharekura teachers teaching pāngarau to years 9–13 students, with a particular focus on developing a range of recommendations for professional development opportunities and for supporting the development of appropriate teaching resources.

Project Team

This project was undertaken as a partnership between the Ministry of Education and a research team from The University of Auckland, Faculty of Education. An advisory group of experienced wharekura and pāngarau teachers also provided advice and guidance on the process.

The Project

The project sought to identify the professional development needs of pāngarau teachers and to provide recommendations to the Ministry of Education to support teachers of pāngarau in wharekura.

Research Questions

The following are the main questions developed to collect the data and to assist in developing the recommendations:

1. What is the current capacity of teachers in wharekura to teach pāngarau in the Māori medium?
2. What are the main issues associated with teaching pāngarau, particularly at NCEA levels 1–3?
3. What are the main professional development needs of pāngarau teachers and what are the best professional development models to suit these needs?

Research Methodology

The research project was based on the premise that the research should benefit both teachers and students in wharekura. Teachers are often sceptical about the benefits of such research, and while this project cannot guarantee that recommendations will be implemented, it is committed to providing positive support for teachers.

Research Method

The project involved collecting data from a range of wharekura throughout Aotearoa where teachers were identified as teaching pāngarau. The project uses the term "pāngarau" as meaning teaching mathematics in the Māori medium. In order to identify appropriate teachers and their schools, the researchers consulted a range of sources, including the Ministry of Education databases.

Data was gathered using questionnaires, personal face-to-face interviews, videoconferencing, telephone conversations, and a hui, involving a number of representatives from the sector. The data was then processed into the first draft recommendation report. This report was critiqued and evaluated by teachers and modifications were made. The resulting second draft report was then presented to the Ministry of Education liaison team who recommended further investigation into one area in particular – prioritising the learning needs of pāngarau teachers.

Overall Findings

Current State of Teaching Pāngarau in Wharekura

The wharekura pāngarau teacher population is aging, as is the general teacher population in Aotearoa. Anecdotally, the number of recent mathematics graduates who teach in wharekura is very low, and this is consistent with teacher supply in mathematics in general. This is recognised by the current TeachNZ Scholarships initiative, which targets areas of priority for teacher supply to meet projected increasing demand over the next 10 years (Ministry of Education, 2007b). Despite such initiatives, there is a scarcity of teachers who are competent to teach in the Māori medium, particularly at the secondary level.

The data collected in this research project reinforces the fact that many teachers teaching pāngarau in wharekura are primary trained.

Overall, the teacher participants in this research project did not rate themselves highly in the area of confidence in the content and assessment of pāngarau.

Professional development Needs of Teachers

Wharekura teachers tend to work in isolation, even those working in the larger urban areas. Professional development opportunities for pāngarau teachers have been limited over the last 20 years or so, unlike English-medium teachers who have had a range of professional development opportunities and assistance from support agencies.

In regard to the components of pāngarau that teachers taking part in this research project wanted support in, the main areas are: student assessment and analysing assessment data, mathematics content, and teaching strategies, with the priorities being assessment of students and content at different NCEA levels.

The ability to find cover for teacher release to attend professional development programmes differed from wharekura to wharekura and region to region.

Most teachers wanted a mixed-mode professional development programme that included mentoring, after-school hui, in-class support, and national wānanga.

Resources

Other than localised material developed by the teachers themselves, there is little quality support resources available for years 9–13 pāngarau and other wharekura teachers.

Wharekura teachers tend to use only the few Māori-medium resources associated with Te Poutama Tau project. English-medium resources are the other principal resources used, and they are used in a variety of ways, including in translation, as guides and references, and as homework exercises. Such resources take the form of traditional textbooks, guides for extension exercises, and guidelines for ensuring that the essential topics and concepts are covered adequately.

Recommendations

Professional Development

This study recommends the following when considering the establishment of an effective professional development programme for wharekura:

Collaborative Network

- The development of an effective collaborative network

  This project recognises that there are opportunities for collaboration with Te Runanga Nui o ngā Kura Kaupapa Māori o Aotearoa and school support services, including school advisors, iwi partnership groups, principals, teachers, and Boards of Trustees to develop an effective and supportive network for teachers in wharekura.

Structure

- The development of a national model, inviting all wharekura to participate
- The appointment of a national co-ordinator to co-ordinate the professional development programme and to liaise with appropriate institutions, wharekura, groups, and individuals
- The setting up of regional mentors/facilitators (wharekura teachers)
- The establishment of resources developers
- The appointment of curriculum/assessment specialists to act as mentors/facilitators.

Delivery Model

In regard to the professional development model preferred by the participants, most wanted a combination of:

- after school and weekend hui, supplemented by videoconferencing to minimise disruption to students (generally because adequate teacher-release cover is not available)
- in-school modelling and support
- block programmes, taking place over 3–4 days per term over a year
- some workshops during school hours if possible.

Content and Priority Areas

Teachers wanted professional development opportunities in relation to years 9–11 teaching and with a focus on the content and practices of NCEA level 1.

Recommended Research

- Research that monitors student outcomes as a result of the professional development programme
- Collaborative enquiry opportunities
- An ongoing evaluation of the programme, including teacher reflections.

Resources

A conceptual framework is developed for teaching students, particularly for years 9–10. This framework should identify the key topics and the conceptual ideas relating to each topic.

Specifically, resources need to:

- take a form that can be modified by developers and/or teachers to reflect contemporary best practice
- reflect the current mathematics education philosophies, that is, focus on the development of strategies
- be electronic, downloadable, adaptable, and interactive
- be designed for ease of use, delivery, and for teachers to make cross-curricular links
- be based on a range of second-language teaching approaches, including the functional, communicative, and grammatical
- support the Number Framework, and, if there is a need to prioritise, provide support for NCEA
- be developed to highlight different Māori tikanga and values, integrate language and culture, and illustrate appropriate socio-cultural contexts for Māori-medium learners.

Recommended Timeline 2008–2009

2008

- Invite wharekura to participate.
- Identify a possible national co-ordinator and mentors.
- Have teacher participants set goals and participate in planning.
- Critically interrogate and reflect on existing teaching practice, data, and personal theories.
- Run a series of workshops, wānanga, etc relating to priority areas.

2009

- Assess the extent to which professional development has improved the quality of teaching and learning outcomes for students.
- Set goals and plan for 2009.
- Run a series of workshops, wānanga, etc on the identified areas for action.

1. Background to Teaching Pāngarau at Years 9+

Introduction

Mathematics has been taught in the Māori medium at years 9–11 since the early 1980s, initially in a few mainstream secondary schools with rumaki units. Some support was provided by the various teacher support services, but the level of support varied greatly in the quantity and quality of Māori language content. Individual schools and support networks developed a limited range of texts in the Māori-language medium . Teachers themselves, with support from Māori language experts and a few academics who specialise in mathematics education, generally initiated the networks. There was minimal resource development and professional development opportunities throughout the 1980s until the development of *Pāngarau i Roto i te Marautanga o Aotearoa* (Ministry of Education, 1996b) and various collaborative projects were instigated between teachers, researchers, linguists, and Te Taura Whiri i te Reo Māori to develop the specialised Māori language discourse necessary to teach the subject. From the 1990s, resource development and professional development has been a component of the Ministry of Education's strategy to support the implementation of the curriculum and, more recently in 2002, it has been made part of the Government's strategy on raising achievement in numeracy.

With limited resources available, most, if not all, the focus of resource development and professional development opportunities has been on providing support for teachers of pāngarau in years 1–8. Naturally, pāngarau teachers and the various support organisations have continued to lobby for support, that is, Te Runanga Nui o Ngā Kura Kaupapa Māori o Aotearoa.

In response to this lobbying and to the current paucity of information on teaching pāngarau, the Ministry of Education has commissioned this report as part of a needs-analysis assessment.

The teaching of mathematics in Māori-medium education is a recent development in this country, particularly at the secondary school level and in wharekura. It has its origins in the range of initiatives to halt Māori language loss and to revitalise the language. Principally, these initiatives were dominated by the birth of kōhanga reo and subsequently kura kaupapa Māori (Christensen, 2003).

Secondary Schools

In the mid-1980s, secondary schools responded to concerns about the promotion and revitalisation of te reo Māori by starting up a number of bilingual units. The bilingual units and/or whānau-type classes operated in a wide variety of schools: urban, rural, single sex, and co-educational (Ohia et al., 1989). The main aims of these bilingual units were to maintain te reo Māori, develop students' self-esteem, develop programmes for Māori students, increase academic achievement, and increase student retention rates in schools (Jacques, 1991).

Along with a number of other curriculum areas, mathematics was also taught in these bilingual units. Mathematics teachers were both Māori and non-Māori; some had no formal mathematics qualifications, but a number were experienced mathematics teachers. A few of the mathematics teachers were also Māori language teachers and/or reasonably fluent in te reo Māori. Prominent amongst these teachers were Uenuku Fairhall, Monty Ohia, and Mihi Maloney (Ohia et. al., 1989).

With a few exceptions, the labelling of these units as "bilingual" was somewhat problematic. The classic definition of bilingual education, posited by Andersson and Boyer (1970) defined bilingual education as "instruction in two languages as mediums of instruction for any part or the entire school curriculum". Simply put, bilingual education involves teaching a subject in two languages (see Baker and Prys Jones, 1998; Cummins, 2003). Almost all the mathematics teaching of this time

was conducted in English, with Māori language used purely for organisation and control. A few Māori words and contexts were introduced to some maths units, but the content did not differ from that found in mainstream schools.

In general, the students' Māori language was not strong, and it is questionable that this initiative addressed the issue of language shift and revitalisation. However, the positive effects of the bilingual programmes were exceptional for social outcomes and attitudes towards "Māori identity" (Ohia et. al., 1989; Jacques, 1991).

The subsequent effects on mathematics learning were positive but less impressive. The change in attitude to schooling also affected a more positive attitude to subjects like mathematics. However the mathematics outcomes were not as positive as the social and cultural outcomes. Initially, most of the Māori language revitalisation was initiated in schools that focused on teaching the core subjects (Keegan, 1996). Historically, in New Zealand schools, mathematics has been considered a high-status subject largely because of the role mathematics has in commerce, industry, etc. Therefore, in developing Māori-medium education, mathematics has fared better than a number of other curriculum areas, particularly in years 1–8 and in the development of subject-specialised discourse.

Because of Māori language proficiency development and the emphasis on language revitalisation, the issue of language has been always at the forefront of Māori-medium mathematics development. Therefore, the teaching and learning of mathematics in the Māori medium has played a significant role in the linguistic and cultural renaissance of Māori language (Barton and Fairhall, 1995; Barton et al., 1998).

Concerns have been raised about the development and emergence of this "new reo" that native speakers often find indecipherable. This issue will need to be considered carefully in any development of pāngarau resources in the future.

Wharekura

Since 1993, the teaching of pāngarau at the secondary school level has witnessed a significant shift from mainstream secondary schools to wharekura. Essentially, wharekura are the year 9–13 component of kura kaupapa Māori schools and, at the time of this research, numbered over 40, including kura teina. Wharekura are also a response by parents, teachers and community to the need to maintain and extend the reo and tikanga.

The number of students attending wharekura Māori (Māori-medium) schooling at secondary level has increased over the past five years. However, the overall wharekura retention rate between year 8 (the kura kaupapa) and year 9 is low, with around half of year 8 students continuing to participate in wharekura at year 9. Common reasons for not participating in wharekura are: inability to access this type of schooling at secondary level and deciding to opt for mainstream secondary schooling (Ministry of Education, 2005).

However, there is a lack of information in regard to the teaching of pāngarau in wharekura or for that matter any curriculum area, hence the need for this report.

Resource Development

Initially, the development of Māori language mathematics resources for secondary school bilingual units was very localised, and resources were developed in the English medium with a sprinkling of Māori terms. The focus was essentially on providing Māori contexts that Māori students could relate to, for example, using the kōwhaiwhai pattern in studying geometric transformations (McKenzie, 1989). In effect, such resources were a catalyst for the development of specialised mathematics terms in te reo Māori.

Much of the early work was done by Toby Rikihana in his development of "resource mathematics" (Rikihana, 1990). Rikihana was also a Māori language expert and was present at a number of bilingual mathematics teachers' workshops in the late 1980s. At the request of the Ministry of Education, he produced a formal list of terms in 1989 (Rikihana, 1989). Also in 1989, Barton and Cleave combined this list with a collection of "terms in use" in the publication *He Kupu Tikanga Tau Aahuatanga* (Barton and Cleave, 1989). In response, Te Taura Whiri i te Reo, supported by Barton, decided to standardise mathematics vocabulary to Form 4 (Barton, 1990).

It took over 20 years for Māori mathematics vocabulary to change from intermittent informal use in primary schools to the more formal use in kura and finally in curriculum documents. The development of the Māori-medium curriculum statement and wharekura accelerated the need to advance the terminology into more specialised terms beyond year 10 (Form 4). This resulted in an expanded dictionary, which drew on the works of Rikihana (1989) and Barton (1990) and was developed to support the introduction of the new curriculum statement (Trinick, 1995). This resource was updated and considerably expanded as *Te Reo Pāngarau – A Māori Language Dictionary of Mathematics* (Ministry of Education, 2004c).

The pāngarau materials have been developed in an ad-hoc manner over the last 20 or so years. However, there has been a more co-ordinated approach since the introduction of Te Poutama Tau professional development programme. A range of very good material has been developed to support the implementation of the professional development programme and to provide further support for teachers. The books of the 2005–2006 Te Poutama Tau Development Project are available in electronic or hard copy form (Ministry of Education, 2007a). Additionally, material masters used in Numeracy Development Projects (NDP) activities are also available. A range of other support material is available in electronic and hard copy form, including equipment animations.

Another significant resource development is the He Pūtahi Pāngarau series (Ministry of Education, 1996a, 1999, 2000). Sixteen titles in total have been written and trialled and six titles have been published in the series. The problem now is that the series is becoming a bit dated. It targets all the strands from levels 1–4, and there are both teacher and student versions. He Tau Anō te Tau (Ministry of Education, 2002, 2004b, 2006) is another useful series of resources, but students and teachers find the level of te reo more complex than the mathematics level in this series.

One of the difficulties of working with translated text lies in the English-language use of colloquialisms, which do not at times translate easily into Māori. The website www.nzmaths.co.nz offers a wide range of web-based Māori-medium materials, including units of work (all strands, levels 1–5), equipment, , digital learning objects, and other materials. Other one-off type publications include a set of readers for infants, Pipi Pāngarau (Ministry of Education, 2005), and a box of problems to solve with a series of books called He Rapanga Pāngarau (Ministry of Education, 2004a).

In summary, there were minimal resource development and professional development opportunities until the development of Pāngarau i roto i te Marautanga o Aotearoa (Ministry of Education, 1996b) and the subsequent Te Poutama Tau project in 2002. With the limited resources available, most, if not all, the focus on resource development and professional development opportunities has related to supporting the teaching of pāngarau in years 1–8. Teaching mathematics in the Māori medium is a recent development in this country, particularly so in the secondary area, and teaching pāngarau in secondary schools has witnessed a significant shift from mainstream secondary schools to wharekura since the mid-1990s.

2. The Project

The purpose of this project was to identify the needs of teachers currently teaching pāngarau in wharekura. Underpinning this project are the following understandings:

- The main objective of this research project is to benefit teachers teaching pāngarau and consequently students learning mathematics in wharekura.
- This research will contribute to a better understanding of the current state of teaching pāngarau in wharekura.
- The Māori-medium resource division of the Ministry of Education is interested in both the current state and needs of wharekura teachers.
- The Ministry of Education will implement the recommendations and will develop a range of professional development initiatives and resources.
- The range of initiatives will support and ease teacher workload in wharekura.

These considerations are based on the key principles of kaupapa Māori, including promoting te reo Māori and Māori cultural aspirations and advancing Māori cultural capital and learning outcomes (Smith, 1997).

Discussions have been held with wharekura teachers to ascertain what their views are on the desired outcomes of the research project.

Project Team

This project was undertaken as a partnership between the Ministry of Education and a research team from The University of Auckland, Faculty of Education. An advisory group of experienced wharekura and pāngarau teachers also provided invaluable advice and guidance on the process and the various iterations of the report.

Advisory Group

The advisory group included Ben Mason,Wharekura o Hoani Waititi; Trist Reweti, Wharekura o Te Rito; and Lynette Carkeek and Malcolm Hyland from the Ministry of Education. Essentially, the role of the advisory group was to provide advice and feedback on process and the various iterations of the research report.

Main Aims

The main aims of this research project were to:

- identify and describe characteristics of teachers in wharekura teaching pāngarau
- describe the characteristics of pāngarau classes in wharekura
- identify the current state of teaching at NCEA levels 1–3
- identify and describe the resources needed to support the teaching of pāngarau
- identify professional development needs of pāngarau teachers and professional development models that best suit them
- provide recommendations to the Ministry of Education on developing resources and professional development programmes to support teachers of pāngarau in wharekura.

Research Methodology

During this research, consideration was given as to how wharekura teachers and students would best benefit from this project. It is fair to say that some kura and Māori-medium schools have tended to be resistant to research projects that do not benefit the school directly or Māori-medium education in general (Bishop, 1997). The participants in this project's were reluctant because they had concerns about whether the report would actually translate into action. It was made clear that the primary purpose of this project was to support wharekura teachers and that the Ministry of Education's intent was genuine. How that intent translates into action, only time will tell.

As a key component of the research methodology, consideration was given to relevant and appropriate approaches to working in Māori immersion and wharekura. Once the wharekura were identified, they were phoned to arrange a suitable time for the researchers to visit to establish positive relationships and to confirm the wharekura's willingness to participate in the project. A variety of methods were used to collect data to identify the needs of teachers in wharekura.

Identifying Wharekura

As noted in previous sections, wharekura are fairly recent developments in Māori-medium education. Wharekura and teachers of pāngarau were identified from information contained in existing databases from the Kaupapa Ara Whakawhiti Matauranga (KAWM) project, from the Ministry of Education database, and from the Te Runanga Nui o Ngā Kura Kaupapa Māori o Aotearoa database. As the researchers conducted interviews, they were able to identify other wharekura not on the established databases. Essentially, these were the kura teina and wharekura that had a designated special character. (See Table 3.1.2. for details on the number and geographic location of wharekura involved in the research project.)

1. KAWM was an ICT-focused Schooling Improvement Project that aimed to strengthen education outcomes in Māori boarding schools, wharekura, and schools in Gisborne, Wairoa, and on the East Coast.
2. Kura teina relates to an initiative by a community that wants to become a kura kaupapa Māori. The community prepares a business case that must then be formally accepted by ministerial approval into the establishment process. During the establishment phase, the kura teina is "attached to", and mentored by, an established high-performing kura kaupapa Māori (referred to as the kura tuakana).

Data Collection

The research aims outlined above were investigated through face-to-face meetings and interviews with teachers in wharekura, using the questionnaire, videoconferencing, audio conferencing, and finally, a combined meeting of wharekura teachers. These processes are described in more detail below.

Kura Kaupapa Māori Hui-a-tau

The research project was presented by one of the researchers to the 2006 hui-a-tau in Matamata. A number of wharekura teachers were present at this hui. Participants at the conference were presented with an outline of the aims and purposes of the project. In general, the project received unanimous support from both wharekura and the runanga nui representatives. Some concern was raised as to whether this research would bear any positive outcomes given that previous submissions from wharekura and the runanga nui had met with little response.

Questionnaire

A questionnaire was sent to all wharekura who had agreed to participate (see appendices 1ñ5). As noted previously, participation was sought by phone or personal visit. Questionnaires were returned by fax, email, standard mail or by hand in the case of personal visits. The questionnaires sought to provide information that would enable the development of a series of recommendations to guide the Ministry of Education to support pāngarau teachers in wharekura. There were five different questionnaires aimed at obtaining specific information as follows:

Questionnaire 1: Demographics of teachers of pāngarau (see Appendix 1)

Questionnaire 2: Teachers' current and previous professional development opportunities (see Appendix 2)

Questionnaire 3: Resource needs to support the teaching of pāngarau (see Appendix 3)

Questionnaire 4: Teaching pāngarau at various NCEA levels (see Appendix 4)

Questionnaire 5: Desired priority areas for professional development needs (see Appendix 5).

Not all sections of the questionnaire were completed by every wharekura and pāngarau teacher.

Videoconferencing

The hui-a-tau was followed up by a videoconference with a number of wharekura. Invitation to participate in the conference was emailed out from an existing KAWM database. Seven wharekura participated in the videoconference. Some of the participating wharekura had been present at the hui-a-tau, most had not. Again the aims of the project were outlined in the invitation to participate, and once more, reservations were raised as to whether any recommendations would be acted on.

Audio Conferencing

Contact was made with wharekura who did not participate in the videoconferencing to seek their support for personal visits and interviews. Again, support for the project was fairly unanimous.

Combined Meeting of Wharekura Teachers

All identified wharekura were invited to a meeting in Tāmaki Makaurau to discuss the research questions and the recommendations. Seventeen teachers from 12 different wharekura attended the meeting. This was the first time for a number of years that teachers of pāngarau at year 9 onward had met as sector. The meeting highlighted the lack of an established infrastructure to support teachers of pāngarau, many of whom work in isolation.

The teachers were presented with the key questions and a summary of the data to date. They were given an opportunity to discuss the issues and provide further feedback. The recommendations were further developed taking the teachers' suggestions into consideration. Subsequently, the recommendations were distributed to all participants for critique and feedback. The final amended recommendations will be discussed in subsequent chapters.

3. The Results and Discussion

The data in this chapter is either displayed in table or chart (bar graph) form. In bar graph form, the y axis relates to the number of teachers.

3.1. Participating Wharekura

This section identifies the number and location of wharekura situated throughout Aotearoa.

Table 3.1.1. Data Sample of Wharekura Participants

Wharekura identified	43
Questionnaires sent out	43
Questionnaires received	20
Personal interviews	30
Wharekura teachers' hui	17

The 20 questionnaires that were completed and returned, the 30 personal interviews, and the hui attended by 17 participants offer a relatively good return statistically given the size of the population (see appendices 1 to 5).

Table 3.1.2. Geographic Location of Wharekura

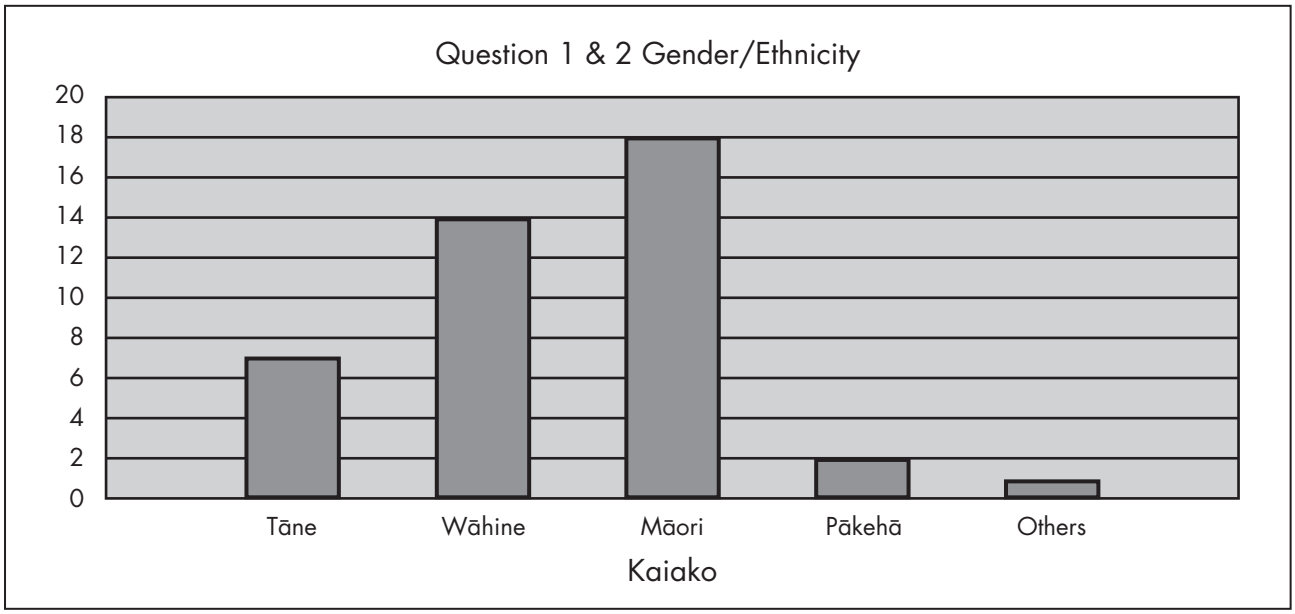
Regions	**Wharekura Tuakana**	**Wharekura Teina**
Te Taitokerau	3	1
Tāmaki Makaurau	3	3
Waikato/Hauraki	2	2
Te Matau-a-Māui	2	3
Taranaki/Wanganui/Manawatū	2	1
Raukawa/Wairarapa	3	
Pōneke	4	
Te Tairāwhiti	1	
Waiariki	5	4
Te Waipounamu	4	1

Geographically, these wharekura are located throughout Aotearoa, in both rural and urban settings, from Te Taitokerau to Te Waipounamu. Many are in isolated regions, and even those in urban areas are the only wharekura in their regions at this point in time. It should be noted that other wharekura might exist that have not been identified. However, this data is useful to assist in developing clusters for professional development opportunities, particularly when combined with rumaki programmes in mainstream secondary schools.

3.2. Current Capacity of Teachers of Pāngarau in Wharekura

This section examines the current capacity and characteristics of teachers in wharekura.

Figure 3.2.1. Gender/Ethnicity



(Refer to questions 1–2 Appendix 1.)

These gender characteristics are fairly common to all teaching in Aotearoa with more women involved in teaching than men. However, the gap between male and female tends to be less significant in secondary teaching.

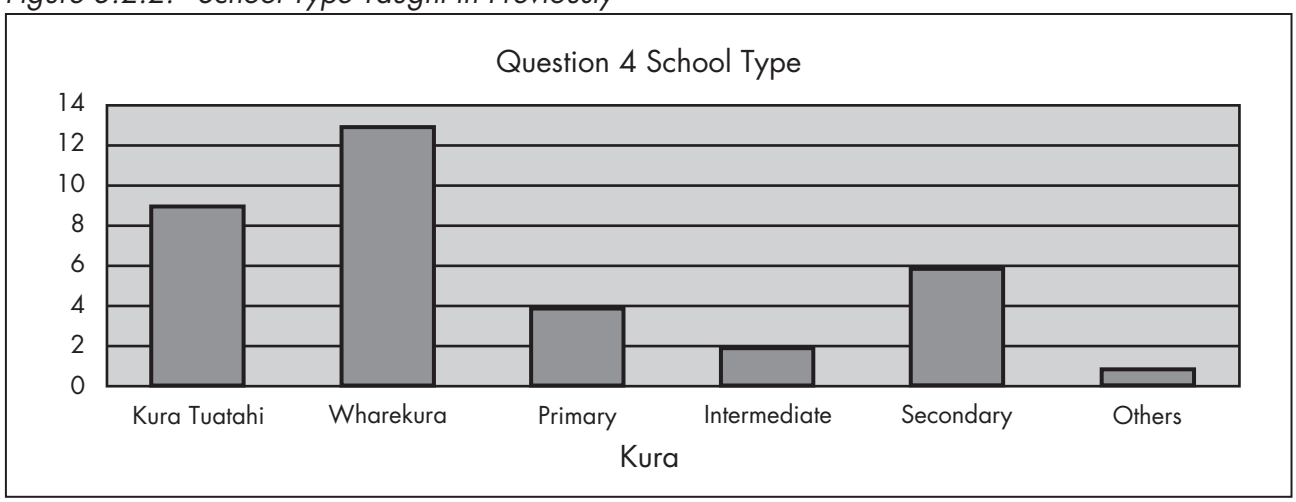
Table 3.2.1. Current Teaching Position of Wharekura Pāngarau Teachers

LAT	Qualified Teachers	Principals
0	18	2

(Refer to question 3 Appendix 1.)

It was anticipated that a number of Limited Authority to Teach teachers (LATs) would be involved in the project because mathematics teaching, and in particular in the Māori medium, is one of the most difficult areas of teaching in which to recruit. However, no LATs were involved in the project.

Figure 3.2.2. School Type Taught in Previously



(Refer to question 4 Appendix 1.)

The teachers participating in the project had previous teaching experience across a range of schools, with a significant percentage being trained for primary teaching. This may be a reflection of noted difficulties in recruiting into secondary pāngarau teaching and the fact that most wharekura have been established only recently. Currently, there is no pre-service or in-service professional development programme available to students and teachers that focuses on pāngarau teaching for years 9+. The Whakapiki Pāngarau programme in Tāmaki Makaurau touches on level 5 of the Number stand, but that is all that is available.

Table 3.2.2. Decile Rating of Wharekura

Decile 1–3	**Decile 4–6**	**Decile 7–9**	**Decile 10**
18	1	1	

(Refer to question 5 Appendix 1.)

The vast majority of wharekura are decile 1–3. In general, these schools tend to struggle for resources. The higher decile kura tend to be located in more affluent areas, but often in such cases, the decile rating does not accurately reflect the socio-economic status of the actual kura community.

Table 3.2.3. Age of Teacher Participants in the Research Project

18–28 Years	29–39 Years	40–50 Years	51–61 Years	62–72 Years
4	7	13	5	

(Refer to question 6 Appendix 1.)

The wharekura pāngarau teacher population is aging, as is the teacher population in general. Anecdotally, the number of recent mathematics graduates who teach in wharekura is very low. This is of some concern and needs to be addressed through future teacher supply initiatives and opportunities for professional development for those currently teaching.

Table 3.2.4. Highest Teaching Qualification

Teaching Diploma	**Graduate Diploma Education**	**Bachelor of Education**	**Post Graduate Diploma**	**Masters Degree**
5	1	8	2	3

(Refer to question 7 Appendix 1.)

This data reinforces the fact that many teachers teaching pāngarau in wharekura are trained in primary teaching. This has implications for the upper areas of the programme, especially in terms of content and NCEA assessment practices. As noted in other studies, primary-trained teachers focus more on teaching pedagogy and examine content up to about level 4 of the marautanga.

Table 3.2.5. Combined Years of Teaching Experience

0–5 Years	**6–11 Years**	**12–17 Years**	**18–23 Years**	**24–29 Years**	**30–35 Years**	**36+ Years**
4	5	6	1	1	1	1

(Refer to question 8 Appendix 1.)

It is difficult to draw any conclusions from Table 3.2.5. except to say that anecdotal evidence suggests many Māori teachers do not stay in the profession for the duration of their careers but tend to move on to other teaching-related careers, such as tertiary teaching, or other careers where their Māori-language expertise and skills are in demand, for example, Māori television or wānanga.

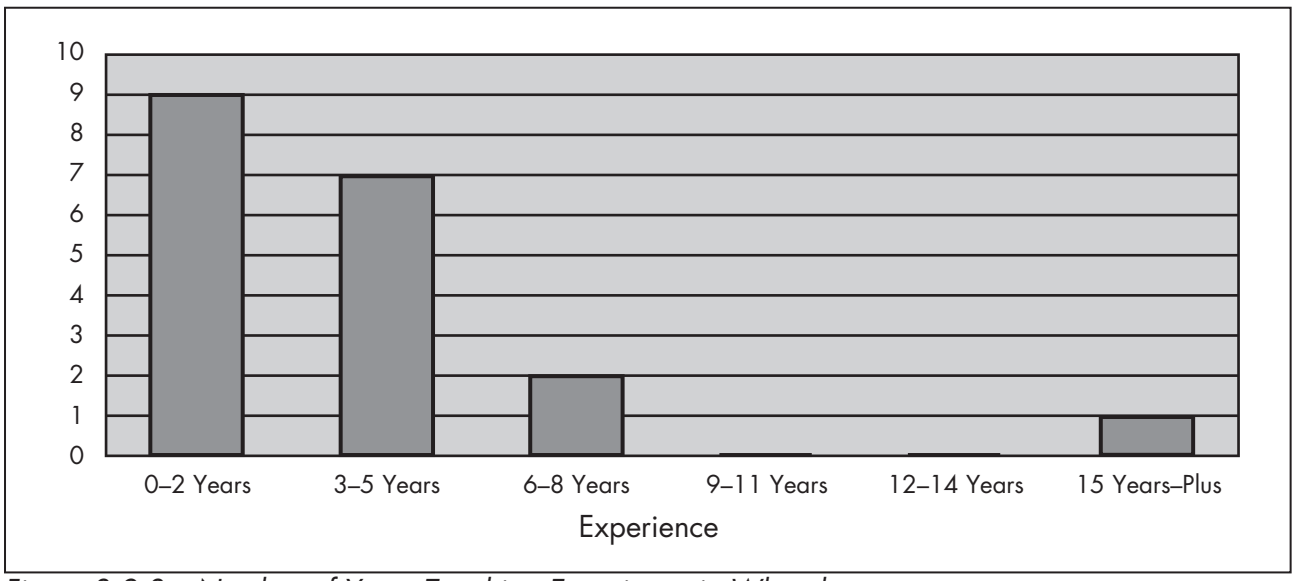


Figure 3.2.3. Number of Years Teaching Experience in Wharekura
(Refer to question 11 Appendix 1.)

The data for this question results from the fact that most wharekura have been established recently. However, it is important to note that the majority of teachers taking part in this project felt that they were relatively inexperienced in teaching pāngarau (see Figure 3.2.5). This has possible implications for the development and implementation of programmes to support NCEA.

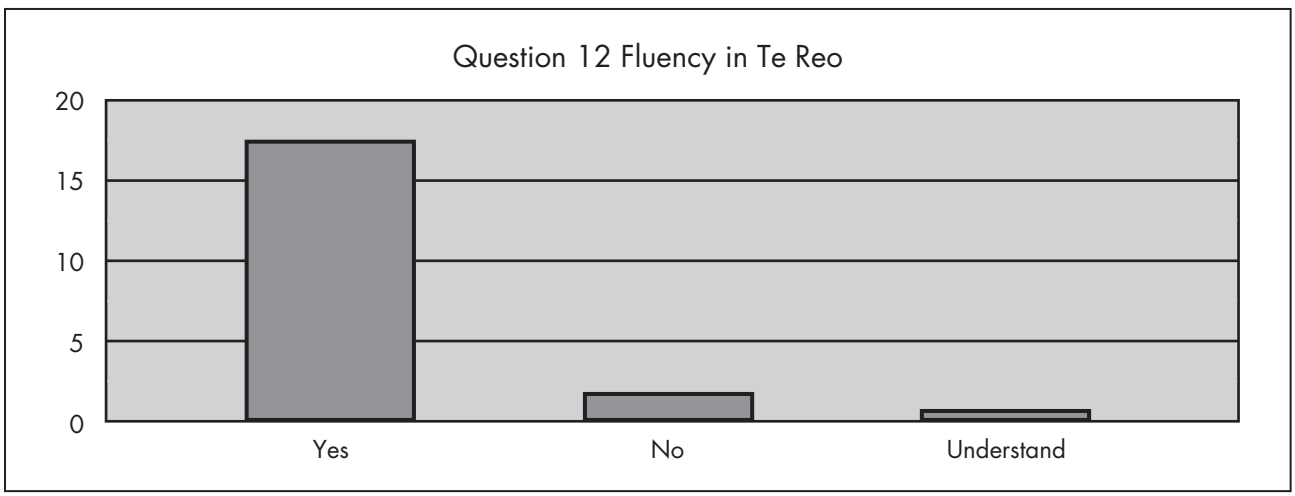
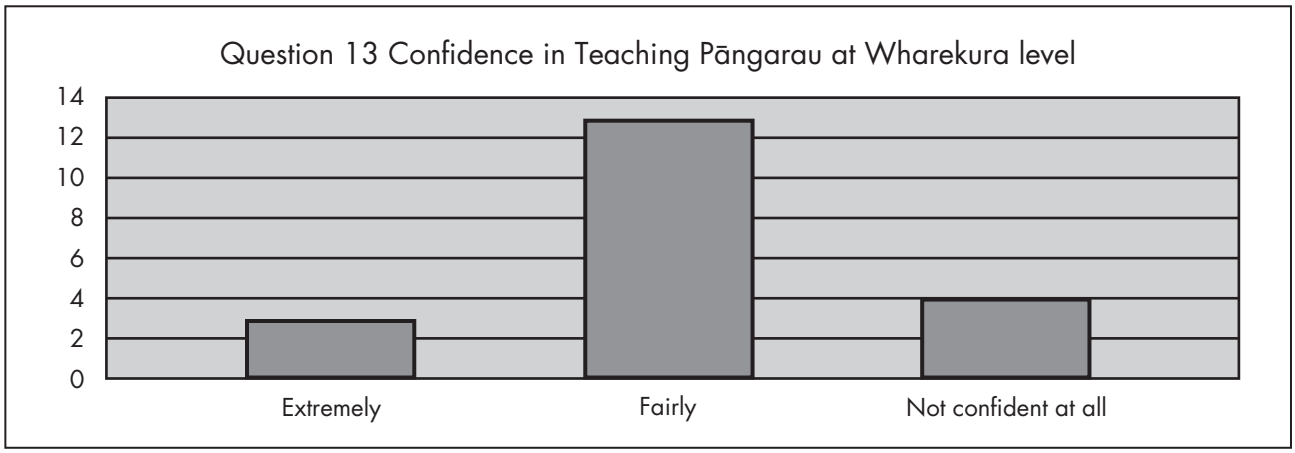


Figure 3.2.4. Fluency of Teachers in Te Reo Māori
(Refer to question 12 Appendix 1.)

The majority of teachers questioned felt that they were fluent in te reo Māori. However, the data does not show these teachers' rating of their fluency in the pāngarau discourse. Fluency in te reo Māori does not necessarily guarantee fluency in te reo pāngarau, particularly as pāngarau is a newly emerging area and the specialised pāngarau register is not often heard and spoken in domains outside mathematics classrooms.

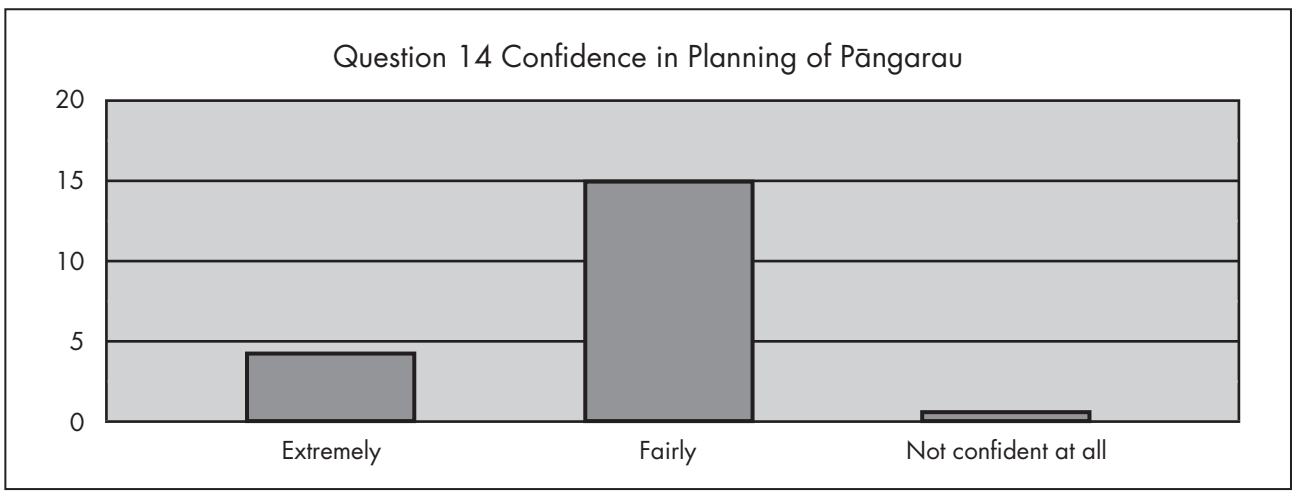
Figure 3.2.5. Teachers Rating of Their Confidence in Teaching Pāngarau



(Refer to question 13 Appendix 1.)

This data suggests that a significant percentage of teachers who participated in this study have only an average to poor confidence in their ability to teach pāngarau at wharekura level. This is not surprising and is consistent with other studies (Christensen, 2003; Trinick, 2004). It does have possible implications for student outcomes and for possible future professional development opportunities.

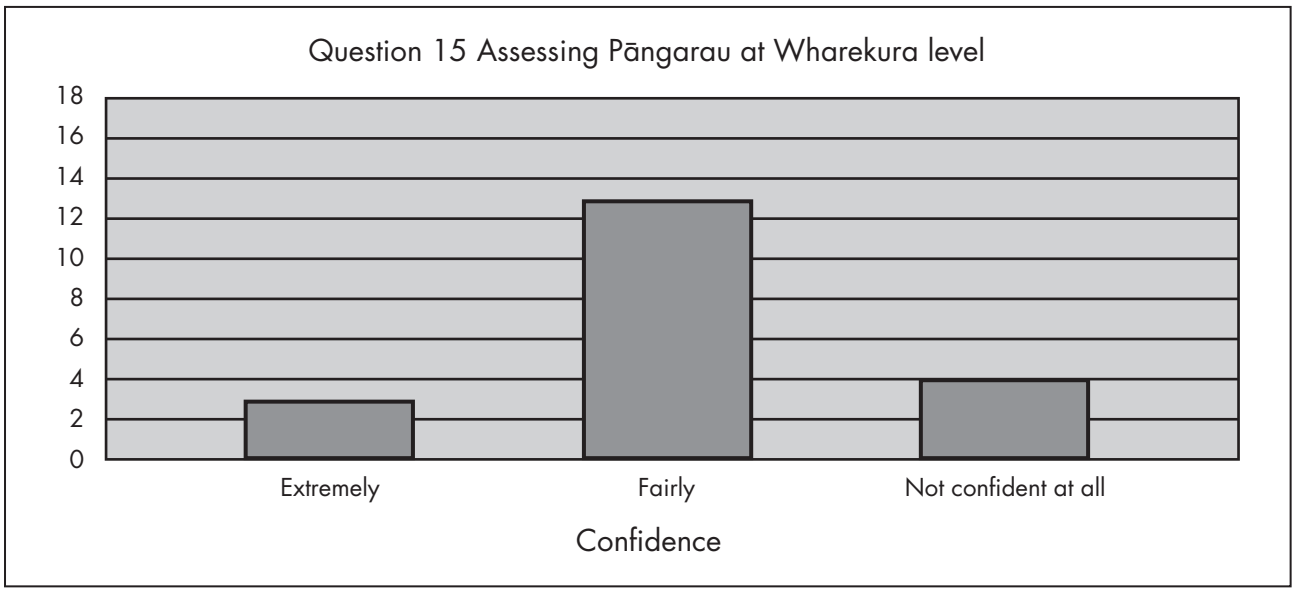
Figure 3.2.6. Teachers Rating of Their Confidence in Planning Pāngarau Programmes



(Refer to question 14 Appendix 1.)

This data closely matches the previous data, which is appropriate considering that confidence in planning is closely linked to confidence in teaching.

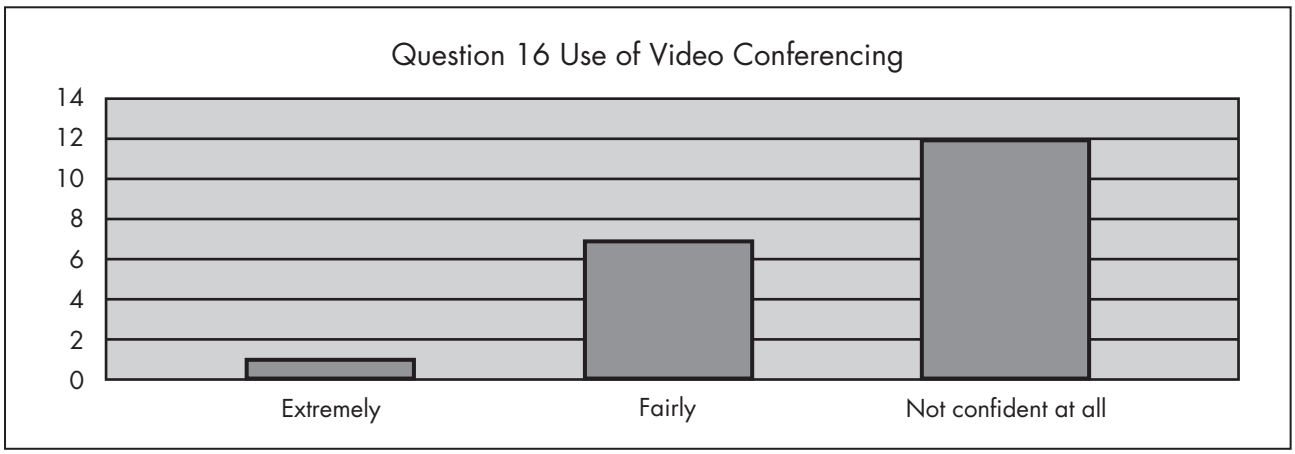
Figure 3.2.7. Teachers Rating of Their Confidence in Assessing Pāngarau



(Refer to question 15 Appendix 1.)

From discussions with teachers, it has become clear that most of the issues to do with assessment relate predominately to the various NCEA levels that have minimal support for Māori-medium education. Again, this data has implications for future resource development, particularly around NCEA.

Figure 3.2.8. Teachers Rating of Their Confidence in Using Video Conferencing



(Refer to question 16 Appendix 1.)

A number of wharekura teachers have been involved in delivering the pāngarau programme to their students via videoconferencing (see KAWM project). The above results may be due to the teachers being passive participants in the delivery process. The data does not clarify whether the teachers lack confidence in the technical or pedagogical aspects of utilising videoconferencing as a teaching tool. Considering the number of professional development opportunities available around ICT, this result is somewhat surprising.

3.3. Professional Development

Previous and Future Professional Development Opportunities

This section examines professional development opportunities teachers have been engaged in and wish to concentrate on in the future (see Appendix 2). Essentially, professional development takes place through three major areas: academic study, pāngarau networks, and school or in-service professional development programmes.

A number of the teachers participating in this project have been engaged in professional study over the years. In general, this has involved upgrading their teaching qualifications from Diploma of Teaching to Bachelor of Education, generally in the English medium. Teachers outside large urban centres have found it difficult to access professional development programmes that can be credited towards a qualification, and the professional opportunities that have been available have not helped teachers to develop their knowledge of the specialised discourse needed to teach pāngarau effectively at the secondary level.

Unlike the English medium, where mathematics associations encourage conferences and professional development opportunities for teachers, professional development for pāngarau has received only limited support through professional links and pāngarau networks. There has been little assistance from the various Vote Education organisations for network development and the development of capacity in wharekura. In the English medium, this support structure exists in the form of teacher support services, university academics, researchers, and others.

Pāngarau teachers often have multiple roles and responsibilities, including teaching in other curriculum areas and providing support for cultural, sporting, and whānau events. The hui of wharekura in Tāmaki Makaurau held as part of this research project was the first time for nearly 20 years that the group had meet as secondary pāngarau teachers! They simply have not had the time to organise pāngarau teachers' networks or to develop their own collaborative infrastructure to provide support.

Teachers recommended that hui be organised to allow participants to share understandings of what is happening in the classrooms and to use a collegial approach in developing, sharing, and implementing programmes and resources. Because of teachers' isolation, it was felt that this should take the form of a national series of wānanga.

In-school support and professional development opportunities for individual teachers of pāngarau and wharekura have also been limited. There does not appear to be any designated position in any of the teacher support services to support pāngarau teaching at wharekura.

Some of the teachers interviewed had been involved in the Te Poutama Tau professional development programme at years 1–9, while others had participated in the English medium Numeracy Development Projects (NDP) at years 7–9. Most (but not all) had been involved in some training around NCEA mathematics. Aspects of the professional development that these teachers found most useful were: the sharing and gaining of knowledge, the collegial support and mentoring, and advice on how to get students to explain "what they have done".

There was variation from wharekura to wharekura and from region to region in terms of ability to find cover for teacher releases to enable teachers to attend professional development programmes. Moreover, all teachers expressed difficulties in finding any relievers with te reo Māori competency and the content knowledge to teach at upper levels.

In regard to the components of pāngarau, teachers felt they needed support in developing assessment tasks, content, analysing student assessment data, and teaching strategies (see Table 3.3.1 below).

Table 3.3.1. Areas of Pāngarau Needing to Be Included in Future Professional Development Opportunities

Content (mathematics knowledge)	13
Teaching strategies	11
Student assessment	12
Planning programmes and lessons	8
Analysing student assessment data	7
Classroom management	7
Te reo Māori mathematics discourse	8

(Refer to question 3 Appendix 2.)

Most teachers questioned felt the need for professional development opportunities in the areas of content, teaching strategies, and student assessment, which is not surprising considering that most of the teachers are kura-tuatahi trained or have expertise in other secondary curriculum areas, such as te reo Māori.

"Teaching strategies" is a somewhat ambiguous term, and this area could have been better defined to distinguish more clearly between mathematics teaching strategies or classroom management teaching strategies. Consequently, it is difficult to interpret the real concerns by analysing the number of teachers who ticked this particular box.

However, when teachers were also asked to prioritise the areas for inclusion in future professional development opportunities, teaching strategies did not come up as a priority area, which suggests that it is not as important an area as content and student assessment.

3.4. Resources

This section is based on the feedback derived from the questionnaire on resources (Appendix 3). Resources in this section relate to the print/electronic materials teachers need to support their teaching of pāngarau. Because of a lack of Māori-medium resources, teachers used a variety of English-medium mathematics resources in a variety of ways to support their teaching (see Table 3.4.1 below). These resources are also commonly used in English-medium mathematics teaching.

Table 3.4.1. English-medium Texts Used in Wharekura

Year	**Resource**
Year 9	Numeracy Development Projects framework, Te Poutama Tau books (1–7), Alpha and Beta homework books, units in mathematics, homework book, Mathematics Matters, NZ Maths, NZAMT resources, digital resources Mathematical World, AME Mathematics
Year 10	Numeracy Development Projects framework, Te Poutama Tau books (1–7), Alpha and Beta homework books, units in mathematics, homework book, Mathematics Matters, NZ Maths, NZAMT resources, digital resources Mathematical World, AME Mathematics, AWS Mathematics, digital resources Mathematical World
Year 11	Units in mathematics, text and homework book NCEA Level 1 as well as unit standards for NCEA 1 and 2, Nulake Year 11 (work and homework books), Theta, Gamma, NCEA correspondence, digital resources, Sigma, Geldof, NCEA revision

Year 12	Units in mathematics, text and homework book NCEA Level 2 as well as unit standards for NCEA 1 and 2, Nulake Year 12 (work and homework books), Theta, Gamma, NCEA correspondence
Year 13	Nulake Year 13 calculus work book, Nulake Year 13 statistics and probability work books, Theta, Gamma

Teachers utilised the English-medium texts in the following ways:

- Various sections, such as homework pages, translated into Māori
- As study guides for NCEA (in English)
- As teacher references
- As independent activities (left in English), with initial interactions and explanations given in Māori
- As revision and homework (in English)
- As supports to attaining achievement standards
- As traditional text books
- As guides for extension exercises
- In their digital form on the Smart Board, that is, NZ Mathematics 9–11
- The explanation section only
- As guidelines to ensure the teacher was covering the essential topics and concepts
- As text used by students and the teacher in translation exercises.

The participants were asked whether any particular English-medium resources should be translated and how such resources could be made more useful for teaching. Many teachers stated that hands-on activities and exercises could be adapted to suit the needs of the students. They did not want translations of instructions, for example, on "doing pages of algorithms".

The Alpha series homework books were suggested as offering good activities that could be useful in teaching pāngarau. The books in this series are easy for students to follow and are useful for NCEA revision. Teachers also wanted pāngarau components that explained the concepts clearly and using ideas and language that students could understand.

Teachers were also asked about their requirements for Māori-medium resources to support them in teaching years 9–11. Following are a few of the comments returned by respondents:

> *At least one textbook in te reo for each level would be useful. But we do not want them to become the programme.*
>
> *In te reo would ease the work loads.*
>
> *We want resources that can be used as independent activities, not necessarily textbooks.*
>
> *We need texts that show a Māori perspective and context relevant to wharekura students.*
>
> *Workbooks would be more useful.*
>
> *There are not any problem-solving questions in te reo appropriate to upper wharekura levels.*
>
> *We would use the texts as a reference, especially for the specialised terms and for explanations.*

Other than localised material developed by the wharekura, there is little quality support material available for teaching pāngarau in years 9–13. Wharekura teachers tend to rely on the few Māori-medium resources associated with Te Poutama Tau project, He Mātauranga Pāngarau, and Te Aka Matua (a resource developed by Kahu Waititi).

A few teachers requested Māori-medium resources that they could use in combination with English-medium resources (in particular, resources that relate to problem solving) and that could be used independently by students. Te Poutama Tau resources were cited as good examples of such resources.

3.5. NCEA and Assessment

The main aim of this section is to identify the current situation in regard to teaching mathematics in wharekura at years 11–13, particularly the high stakes in relation to assessments. Information for this section is derived from Appendix 4: Questionnaire, Pāngarau at Years 11–13. A number of wharekura are teaching to at least NCEA level 2 (see Table 3.5.1 below). This has significant implications for teachers, students, whānau, NZQA, and so on.

Table 3.5.1. The Number of Wharekura Teaching to the Various NCEA Levels

Teaching Pāngarau In Years 11–12		
	YES	NO
NCEA 1	17	3
NCEA 2	11	8
NCEA 3	7	13
Unit standards	15	5

(Refer to questions 1–5 Appendix 4.)

As was expected, most of the teaching occurs at NCEA level 1, and as noted earlier, there is a gradual drop in wharekura teacher numbers over subsequent levels. This is essentially due to two factors: students not taking pāngarau at the higher levels and students transferring to English-medium schools.

A large number of wharekura use unit standards, either to complement achievement standards or as a substitute for achievement standards. Teachers found unit standards easier for planning, teaching, and assessing purposes.

Table 3.5.2. Language of Instruction, Interaction, and Learning

Teaching Pāngarau to Years 11–12			
	Te Reo Māori	Bilingual	English
NCEA 1	10	2	4
NCEA 2	4		7
NCEA 3	2		5
Unit standards	11	1	5

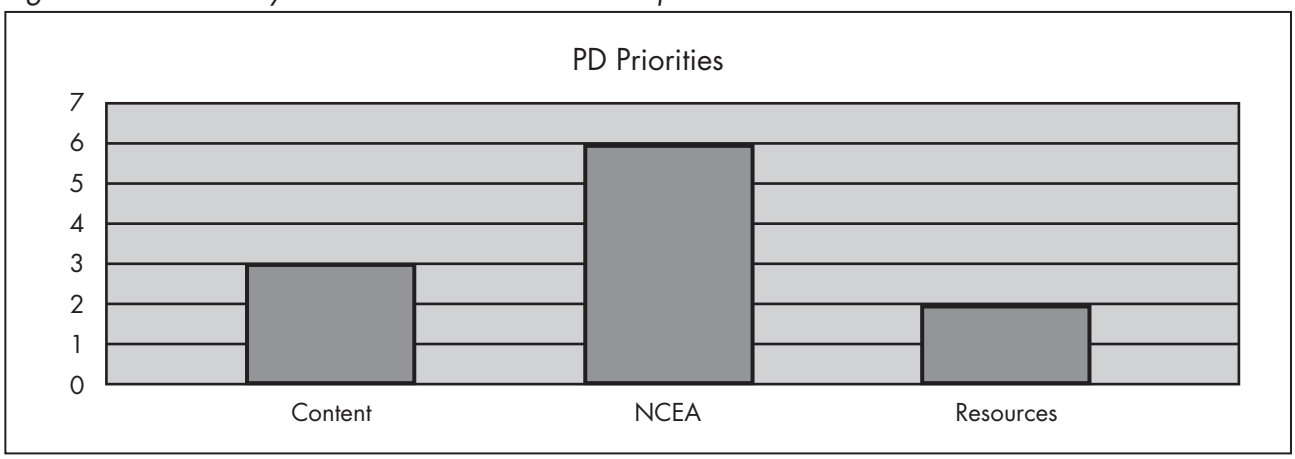
(Refer to questions 2–6 Appendix 4.)

The majority of Māori-medium teaching in the upper levels occurs at NCEA level 1. It is not known at this point whether an indication of bilingual teaching relates to teaching subject content in Māori or using Māori as the language of classroom management. The latter is more likely. The data relating to the range of resources used suggests that even those who indicated that they teach in Māori use English resources from time to time when there are no Māori-medium resources available.

3.6. Priority Areas for Professional Development and Resources

As a consequence of discussions with the Ministry of Education facilitators, the researchers for this project were asked to go back and ask teachers to prioritise professional development and resource needs. An additional questionnaire was then sent out to participating teachers (see Appendix 5).

Figure 3.6.1. Priority Areas of Professional Development



(Refer to Appendix 5.)

Most of the participants questioned wanted support with developing and implementing NCEA. They also requested resources that would support teaching programmes for NCEA. It is not surprising that NCEA is a top priority as this assessment has high stakes and has significant implications for students' future study and career opportunities.

Collectively, the teachers taking part in this research project had been involved in a range of professional development opportunities and models of delivery and support. However, very little of this professional development specifically related to supporting teaching pāngarau at years 9–11. The lack of suitable relievers to free up teachers for professional development programmes was an issue, but teachers did not want to see this addressed by after-school and holiday workshops alone. They wanted a range of opportunities to be applied over 2–3 years. Additionally teachers favoured:

- in-school modelling and support
- block programmes over 3–4 days per term (Ideally these would take the form of national conferences.)
- workshops during school hours.

Teachers wanted a balanced range of options but realised that the issues of teacher release and disruption to classes would create additional stresses, particularly around exam preparation time.

4. Recommendations

The purpose of this project was to answer the following key questions and to provide recommendations on how the issues raised with these questions could be addressed:

1. What is the current capacity of teachers in wharekura to teach pāngarau in the Māori medium?
2. What are the main issues associated with the teaching of pāngarau, particularly at NCEA levels 1–3?
3. What are the main professional development needs of pāngarau teachers, and what are the best professional development models available to suit these needs?

Once the data was collated and analysed, a range of draft recommendations was developed and disseminated for critique and feedback. The pāngarau wharekura teachers' hui provided one forum for representatives in the sector to review the recommendations, and the draft recommendations were also circulated to all teachers participating in the project. The draft recommendations were also then presented to the Ministry of Education liaison team for their feedback. The original data and the feedback have informed the recommendations that follow.

4.1. Professional Development

There is a huge weight of evidence that argues that teachers make a significant difference to learner outcomes (Anthony, G and Walshaw, M. 2007) and that teachers have a significant role to play in improving educational outcomes of students. However, much of this research has concentrated on English-medium contexts only.

4.1.1. Effective Collaboration and Network Development

A foundational principle of effective professional development is effective school and teacher partnerships with students, parents, whānau and communities (Bishop and Glynn, 2003; McFarlane, 2004; Tuuta et al. 2004). Students, families, and teachers can work together actively to improve the school culture and teaching, and they are assisted by support, feedback, and accountability mechanisms to raise achievement (Tuuta et al., 2004).

The roles and relationships that need to be established as part of any professional development programme are critical to successfully implementing skills that are learned during such programmes (Trinick, 2005). Relationships help in developing networks that encourage and build on capacity in Māori-medium kura. Such relationships link the various support agencies, the kura, whānau, hapū, researchers, and advisors.

There are opportunities for collaboration between:

- Te Runanga Nui o Ngā Kura Kaupapa Māori o Aotearoa
- school support services, including school advisors
- iwi partnership groups, such as the Tūhoe Education Authority
- principals, teachers, and Boards of Trustees
- teacher education providers
- researchers and evaluators
- school improvement projects
- curriculum specialists.

4.1.2. Recommended Structure

A structure should be developed that provides support in implementing professional development programmes for wharekura, and this structure should be based on the current conditions and needs of the wharekura. It is recommended that a nation-wide structure be developed and all wharekura be invited to participate in this structure. This recommendation is based on the following considerations:

- Pāngarau teachers at wharekura tend to work in isolation. They do not belong to mathematics departments like the bigger and more numerous English-medium secondary schools.
- Wharekura are often geographically isolated.
- A collaborative model needs to be developed (see 4.1.1. Effective Collaboration and Network Development).

A National Co-ordinator

Wharekura teachers are faced with a number of issues in teaching pāngarau. The rationale for developing a national co-ordinator role is based on the following considerations:

- A national rather than geographic or regional structure is needed to provide reasonable economies of scale.
- A national co-ordinator will enable the range of issues that are impinging on the teaching of pāngarau to be dealt with more effectively and efficiently with a co-ordinated, holistic approach.
- See role description below.

Regional Mentors/Facilitators (Wharekura Teachers)

The data shows that there are teachers who have content knowledge, language proficiency, and experience in most regions (see 3.2 Current Capacity of Teachers of Pāngarau in Wharekura). These teachers could be encouraged to take up the role of mentor/facilitator. The rationale for having mentors/regional facilitators is based on the following considerations:

- The expertise that already exists within different regions should be utilised and made accessible to all within the region.
- Communities of practice need to be developed regionally and locally.
- Mentors could help sustain the programme beyond the duration of the contract.
- See role description below.

Evaluators and Researchers

It is important to evaluate the effectiveness of the professional development opportunity on student outcomes. Evaluation and research recommendations are predicated on wharekura teachers setting their goals appropriately to cater for their students learning needs as well as their own professional development needs. To this end, we recommend the following:

- A range of tools for measuring evidence of change should be explored.
- An inquiry focus should be established.
- Criteria for measuring learning progress should be developed, that is, a Māori-medium Number Framework.

- An action research plan is developed.
- A framework for judging quality of evidence should be developed.
- Evidence of teacher and learning "shifts" should be identified.

Resource Developers
A variety of experts could be called on to develop appropriate resources:

- Publishers should be asked to develop high-quality Māori-medium resources that are funded by the Ministry of Education. (Because of the small numbers in wharekura, publishers do not currently produce material to the same extent that they do in the English medium (see Table 3.4.1. English-medium Texts Used in Wharekura).
- Mentors and teacher participants with appropriate skills should develop and share resources.

Curriculum/Assessment Specialists
In most situations, this role could be filled by the mentors/facilitators, but it would be useful from time to time to bring in outside expertise.

Recommended Roles and Responsibilities

Key Tasks

The National Co-ordinator – Wharekura Project

The national co-ordinator will be responsible for:

- liaising with the appointed Ministry of Education facilitator for the project
- developing collaborative partnerships and relationships with key stakeholder groups
- supporting the project manager in planning and implementing the programme
- liaising with the programme co-ordinators of the graduate programmes at Universities or Wānanga where courses are available
- liaising with advisors and curriculum specialists
- ensuring time frames are created and adhered to for development programmes for cluster schools
- ensuring milestone reports are written
- contributing to the planning and implementation of the professional development programme.

Regional Mentors/Facilitators
The regional mentors/facilitators will be responsible for:

- supporting wharekura teachers in their regions in teaching pāngarau
- assisting with the development of programmes, resources, and assessment tasks.

Evaluators and Researchers
The evaluators/researchers will be responsible for:

- applying relevant theoretical frameworks to assist wharekura and individual teachers with implementing a co-ordinated inquiry-based and participatory research project
- guiding mentors and encouraging teachers' engagement with evidence-based practices (including the Ministry of Education's Iterative Best Evidence Synthesis (BES) programme of work)

- working as co-inquirers with teachers and supporting research and development activities
- contributing to the on-going planning, development, and possible modification of activities related to the wharekura pāngarau project
- working with the wharekura project to develop a set of protocols, principles, and practices to guide collaborative inquiry projects
- identifying the impact that the professional development programmes for wharekura classrooms have on learning
- identifying the patterns of performance and the progress of wharekura students involved in the project.

4.1.3. Recommended Delivery Model

Based on respondent feedback, we recommend the following:

- After-school and weekend meetings and workshops, supplemented by videoconferencing to minimise disruption to students because adequate release cover is not currently available
- In-school modelling and support
- Block programmes that take place over 3–4 days per term over a year, with progress being monitored (see previous recommendations on evaluating outcomes)
- Workshops during school hours.

4.1.4. Recommended Content and Priority Areas

As noted earlier in terms of what teachers felt should be included in future professional development for wharekura teachers, the priority areas relate to mathematical content and assessment, including NCEA assessment practices and the development of appropriate resources to support these practices. The content areas for professional development should also match any development of resources.

4.1.5. Recommended Timeline

It is recommended that a programme be developed that takes place over at least three years to start in 2008. From previous experience with the Te Poutama Tau project it has shown these types of projects need at least three years of research and development to be really effective.

4.2. Recommendations regarding Resources

Below are some generalised recommendations regarding resource requirements.

4.2.1. A Conceptual Framework

In the absence of Māori-medium resources, teachers currently have to rely on the marautanga pāngarau and English-medium resources. However, many teachers (particularly primary-trained teachers or non-pāngarau specialists) have difficulty interpreting the whāinga paetae (achievement objectives) contained in English-medium resources. Additionally, the English-medium resources do not provide any support for developing the specialised terms, register, and discourse, which are critical to developing good conceptual understandings (Christensen, 2003). Similarly, these resources do not support contexts that students in wharekura can relate to. In considering these issues, this report recommends the development of a conceptual framework for teaching students in years 9–10. The programmes for students in years 11–13 tend to be much more prescriptive in order to meet NCEA requirements.

This framework should identify the key topics and conceptual ideas relating to each topic, such as tau tōpū (integers), and incorporate key teaching strategies and ideas into the framework. It is also important that the framework maintain the momentum of the maths focus of developing strategies, which is a key component of the Te Poutama Tau programme for kura tuatahi. The framework should also prioritise training areas for teachers of students in years 9–11.

4.2.2. Language of the Resources

While there is some support for bilingual resources, it would be more useful to develop resources in te reo Māori, with the aim of developing te reo Māori discourse fluency. Bilingual resources tend to tempt students and teachers to refer to the English medium.

4.2.3. Learning Teaching Pedagogy

Although mathematics content has not changed drastically over the last 10 years or so, there have been significant changes in the way mathematics is taught (pedagogy). There is less emphasis on doing pages of "exercises" that promote learning by repeated practise. Resources need to take a form that can be modified by developers and/or teachers to reflect contemporary best practice. These resources will:

- reflect the current mathematics education philosophies, that is, focus on the development of strategies
- be activity- or task-based, allowing plenty of opportunity for interaction (this encourages communication, which is a key process in learning mathematics)
- be student-centred and use activities and contexts that students can identify with
- reflect the varied interests of te rangatahi in ways that will not date the materials too quickly
- allow for flexibility (to accommodate students' diverse needs and prior experiences – as well as local needs)
- promote learner autonomy – not always be teacher directed. This allows for the learner to take more control of their own learning and requires less teacher direction, giving teachers more time to support individual groups of learners.

4.2.4. Forms of Resources

In general, we feel there is a need to develop a range of resources, including:

- electronic resources that teachers could adapt as necessary, that is, in relation to such elements as specific context or vocabulary
- interactive whiteboard resources that could be downloaded and frequently updated
- blackline masters, that is, worksheets of independent activities
- interactive resources that encourage the use of a range of technologies.

4.2.5. The Design of Resources

Resources should be presented in a quality format that:

- includes illustrations and examples of quality Māori language
- makes the resource easy for teachers to use confidently
- makes the implementation/delivery of lessons as straightforward as possible

- focuses on a range of activities that enhance a variety of skills (for example, problem solving, ICT, listening, reading, speaking)
- is based on a range of second-language teaching approaches, including the functional, communicative, and grammatical approaches.

4.2.6. The Content of Resources

Initially expanding into the higher levels, the resources and ideas should support the Number Framework. Teachers need resources for all curriculum areas and topics, however, if there is a need to prioritise, resources should be developed that support NCEA (see Figure 3.6.1. Priority Areas of Professional Learning).

4.2.7. Connection to the Marautanga and other Relevant Resources

Reference to other pāngarau language resources available in schools, for example, the Number Framework, creates opportunities for teachers to make cross-curricular links, for example, between mathematics and social studies.

4.2.8 Cultural Considerations

When teaching English to someone from the Pacific, a teacher needs to use a totally different approach/programme to that they would use when teaching English to someone from the Middle East in order to address different cultural expectations. This is often accepted in the case of teaching English but doesn't seem to have been generalised to teaching other subjects, such as mathematics, particularly in the Māori medium. Therefore, this report recommends that resources be developed that:

- highlight different Māori tikanga and values
- illustrate appropriate socio-cultural contexts for Māori-medium learners
- integrate language and culture.

Kāti i kōnei. Ko te tūmanako ka tutuki i ngā wawata o ngā kaiwhakaako kei roto i

ngā wharekura otirā, ngā wawata o ngā whānau. Nō reira, ko tēnei te mihi atu ki ngā kaikōrero katoa.

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Appendix 1

TE PUNA WANANGA
FACULTY OF EDUCATION

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NEW ZEALAND

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Questionnaire: Teacher Demographics - Te Rārangi Patapatai mō te Hunga Pouako

Kia ora Koutou.

We are conducting a research project to identify the needs of mathematics teacher's years 9-11 in Wharekura. Feedback from principals and teachers will provide the essential information to enable us to make recommendations to the Ministry of Education and key stakeholder groups

1. Select your gender

   ☐ Male

   ☐ Female

2. Select your ethnicity

   ☐ Māori

   ☐ Pākehā

   ☐ Other

3. Choose from the list below the position that best describes your current position

   ☐ Limited Authority to teach

   ☐ Qualified teacher

   ☐ Principal

4. Choose from the list below the school type that you have taught in previously

- ☐ Kura tuatahi
- ☐ Wharekura
- ☐ Mainstream primary school
- ☐ Mainstream intermediate school
- ☐ Mainstream secondary school

5. What is the decile rating of your school?

- ☐ Decile 1 - 3
- ☐ Decile 4 - 6
- ☐ Decile 7 - 9
- ☐ Decile 10

6. Select the age range that you fit into.

- ☐ 18 - 28 years old
- ☐ 29 - 39 years old
- ☐ 40 - 50 years old
- ☐ 50 - 61 years old
- ☐ 62 - 72 years old

7. What is the highest teaching qualification you currently hold?

- ☐ Teaching Diploma
- ☐ Graduate Diploma
- ☐ Bachelor of Education
- ☐ Post Graduate Diploma
- ☐ Masters Degree
- ☐ Doctorate Degree

8. Which of the following range of years, best describes your years of teaching experience?

- ☐ 0 - 5 years teaching experience
- ☐ 6 - 11 years teaching experience
- ☐ 12 - 17 years teaching experience
- ☐ 18 - 23 years teaching experience
- ☐ 24 - 29 years teaching experience
- ☐ 30 - 35 years teaching experience
- ☐ 36 years or more, teaching experience

9. Which of the following year groups do you teach mathematics to?

- ☐ Year 9
- ☐ Year 10
- ☐ Year 11
- ☐ Year 12
- ☐ Year 13

10. Which of the following year groups do you teach pāngarau in the medium of Māori to?

- ☐ Year 9
- ☐ Year 10
- ☐ Year 11
- ☐ Year 12
- ☐ Year 13

11. Which of the following range of years, best describes your years of teaching mathematics at Wharekura in the medium of Māori?

- ☐ 0 - 2 years teaching experience
- ☐ 3 - 5 years teaching experience
- ☐ 6 - 8 years teaching experience
- ☐ 9 - 11 years teaching experience
- ☐ 12 - 14 years teaching experience
- ☐ 15 years or more, teaching experience

12. Are you a fluent speaker of te reo Māori?

- ☐ Yes. I am able to teach my whole class in te reo Māori.
- ☐ No. I am unable to teach my whole class in te reo Māori
- ☐ I am not able to teach my whole class in te reo Māori, but I understand the Māori language.

13. How would you rate your confidence in the teaching of pāngarau at Wharekura level?

- ☐ Extremely confident
- ☐ Fairly confident
- ☐ Not confident at all

14. How would you rate your confidence in the planning of pāngarau at Wharekura level?

- ☐ Extremely confident
- ☐ Fairly confident
- ☐ Not confident at all

15. How would you rate your confidence in the assessing of pāngarau at Wharekura level?

- ☐ Extremely confident
- ☐ Fairly confident
- ☐ Not confident at all

16. How would you rate your confidence in the use of video conferencing?

- ☐ Extremely confident
- ☐ Fairly confident
- ☐ Not confident at all

17. What topics or aspects of pāngarau do you find most challenging?

Appendix 2

Questionnaire: Previous/Future Professional Learning Opportunities

1. What courses or professional learning in pāngarau have you been engaged in, and what aspects have you found useful?

Course & Year	**Useful aspects**

2. How difficult has it been to find relievers?

- ☐ Extremely difficult
- ☐ Difficult, but they are available occasionally
- ☐ Generally available
- ☐ Available when ever we need them

Future PD

3. What aspects of pāngarau would you like professional learning in?

- ☐ Content (mathematics knowledge)
- ☐ Teaching (strategies)
- ☐ Assessment
- ☐ Planning
- ☐ Data analysis- student outcomes
- ☐ Classroom and group organisation and management
- ☐ Te reo pāngarau
- ☐ Other areas

4. Which professional learning model do you prefer? What are the effective professional learning models that would best suit your needs?

   ☐ Workshops after schools and in the weekends

   ☐ In–school modelling and support

   ☐ Combination of the above two

   ☐ Other models

Appendix 3

Questionnaire: Mathematics Resources

1. What English-medium mathematics resources do you currently use for:

   Year nine

   Year ten

   Year eleven and above?

2. How do you use them?

3. How useful is each one? What aspects of the resource are useful?

4. In your view should they be translated into Māori and or how can they be made more useful?

5. What Māori medium mathematics resources do you currently use for:

   Year nine

   Year ten

   Year eleven and above?

6. How do you use them?

7. How useful is each one? What aspects of the resource are useful?

8. How can they be made more useful?

New Resources

1. What additional resources do you need?

Format/Medium

2. If texts, in what form should they be in?

- ☐ A textbook
- ☐ A4 format (hole-punched and subfigure for storage in ring-binders).
- ☐ All of the above
- ☐ Other (please describe)

3. Should the resources be bilingual or just te reo Māori?

- ☐ In English with Māori contexts
- ☐ Bilingual
- ☐ Te reo Māori
- ☐ Other (please describe)

If bilingual, what would be most useful to have in English and what would be best to have in Māori?

Content

4. Should the content include:

- ☐ Introductory section?
- ☐ Connections to marautanga?
- ☐ Connections to unit standards?
- ☐ Explanation of mathematical concepts?

- ☐ Problem-solving type activities for students?
- ☐ Teachers notes and or teachers copy?
- ☐ Other-please explain?

5. Should the focus be on all topic areas or prioritise? What topics would be top priority?

- ☐
- ☐
- ☐
- ☐
- ☐
- ☐
- ☐

6. Should there be references in the resource/s to NCEA Achievement Standards and the pāngarau curriculum statement? What other kinds of references would be most helpful?

Appendix 4

Questionnaire: Pāngarau at Year 11–13

1. Do you offer a NCEA Level 1 pāngarau programme?

   ☐ Yes

   ☐ No

2. If yes, what language do you predominately teach in?

   ☐ Te reo Māori

   ☐ English

3. Do you offer a NCEA Level 2 pāngarau programme?

   ☐ Yes

   ☐ No

4. If yes, what language do you predominately teach in?

   ☐ Te reo Māori

   ☐ English

5. Do you offer a NCEA Level 3 pāngarau programme?

   ☐ Yes

   ☐ No

6. If yes, what language do you predominately teach in?

   ☐ Te reo Māori

   ☐ English

7. Do you offer a pāngarau unit standards programme?

   ☐ Yes

   ☐ No

8. If yes, what language do you predominately teach in?

   ☐ Te reo Māori

   ☐ English

Appendix 5

Priority Areas for Professional Learning.
Tau 9–13

Kei te hiahia te Tāhuhu ki te mōhio he aha ngā tino kaupapa whakangungu e hiahiatia e koutou, mai i te tino kaupapa heke noa. Me whakarārangi haere ngā kaupapa i raro, i te tino kaupapa (1), ki te kaupapa tuarua (2), ki te tuatoru (3), ā haere tonu

☐	Planning Tau 9–10 What topics to teach	☐ Tau 9 ☐ Tau 10
☐	Planning Tau 11–13 Course outlines i.e. what AS and/or US to teach and why? Internal vs. external How to effectively organise course	☐ NCEA 1 ☐ NCEA 2 ☐ NCEA 3
☐	Assessments Tau 9–10 What sample assessments are available? How do I design effective assessments? How do I make effective use of the data?	☐ Tau 9 ☐ Tau 10
☐	Assessments Tau 11–13 What sample AS are available? What are sample contexts for AS for Wharekura?	☐ NCEA 1 ☐ NCEA 2 ☐ NCEA 3

☐	Resources Tau 9–10 What te reo Māori resources are available i.e. locally produced	☐ Tau 9 ☐ Tau 10
☐	Resources Tau 11–13 What resources are available to support AS/US?	☐ NCEA 1 ☐ NCEA 2 ☐ NCEA 3
☐	Content areas Tau 9–10 The content areas I need most help with?	☐ Tau ☐ Ine ☐ Taurangi ☐ Āhuahanga ☐ Tauanga
☐	Content areas Tau 11-13 The content areas I need most help with?	☐ Ine ☐ Taurangi ☐ Āhuahanga ☐ Tauanga
☐	He whakaaro Anō	

US= Unit standards
AS = Achievement Standards

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